FLOOD COMMISSION
PITTSBURGH
PENNSYLVANIA

REPORT OF
FLOOD COMMISSION
OF PITTSBURGH, PENNA.


OHIO
RIVER

RELIEF MAP OF PITTSBURGH, ALLEGHENY & VICINITY

OF THE

PITTSBURGH CHAMBER OF COMMERCE

BY

Topography from U. S. Geological Survey sheets. Buildings, bridges, railroad grades, locks, dams, etc. modeled with data from other sources.

LETTER OF TRANSMITTAL.

TO THE CHAMBER OF COMMERCE OF PITTSBURGH:

I have the honor to submit herewith the report of the Flood Commission of Pittsburgh, which was organized February 20, 1908, for the purpose of ascertaining means of relief from the floods which have so frequently occurred, with damaging results, to this community. This Commission was created by a resolution adopted by the Chamber of Commerce of Pittsburgh, to which organization the thanks of the people of this and other communities are due, for taking the initiative in the most complete study of this broad subject that has ever been accomplished in this country.

I am glad to make mention of the constant attention and untiring zeal displayed by my colleagues, all of whom are business and professional men of the highest standing; of the financial and other assistance rendered by the city and county officials; and of the contributions of funds made by citizens, firms and corporations, without which generous aid the carrying on of this work would have been impossible.

Special credit is due the members of the Engineering Committee, whose untiring attention to the work has been freely given and, with the exception of the Engineer in Charge, without remuneration. This committee has succeeded in solving a difficult problem and has provided a comprehensive report, which is presented with the belief that it not only forms a solution of the problem of flood relief for our own city, and many communities on the rivers above and below, but also shows other benefits to be obtained for the general public welfare, notably: improvements to navigation, water power, water supply and sanitary conditions.

The investigations have been made with conscientious care, both in field and office; and the study, first thought to be of local application only, has broadened out until the plans and recommendations of the Flood Commission, while having specific relation to conditions at and in the vicinity of Pittsburgh, are applicable in nearly every part of this country similarly suffering from floods. That such a report, with its magnitude of data from many sources and, in some cases, covering a period of many years, will be absolutely perfect in every detail, is more than can be expected; but it is submitted with confidence that the public, particularly those having scientific training, will accept the report in a spirit of earnest endeavor to study for the truth these facts and recommendations now made public through the Chamber of Commerce. Fair-minded criticism and comment based upon facts carefully determined and not upon previous opinions without accurate data will be of assistance in serving a great public good and aiding in this movement of national importance.

Respectfully submitted,

H. J. HEINZ,

President, Flood Commission of Pittsburgh.

April 16, 1912.

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REPORT OF

FLOOD COMMISSION

OF PITTSBURGH, PENNA.

CONTAINING THE RESULTS OF THE SURVEYS, INVESTIGATIONS AND STUDIES MADE BY THE COMMISSION FOR THE PURPOSE OF DETERMINING THE CAUSES OF, DAMAGE BY AND METHODS OF RELIEF FROM FLOODS IN THE ALLEGHENY, MONONGAHELA AND OHIO RIVERS AT PITTSBURGH, PENNA., TOGETHER WITH THE BENEFITS TO NAVIGATION, SANITATION, WATER SUPPLY AND WATER POWER TO BE OBTAINED BY RIVER REGULATION.

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*Appendix.

†Where map case does not accompany the report, this map will be found in pocket at back of book.

A 5,	5th	sheet	up	Allegheny	River
M 1,	1st	"	"	Monongahela	River
M 2,	2nd	"	"	"	"
M 3,	3rd	"	"	"	"
M 4,	4th	"	"	"	"
O 1,	1st	"	down	Ohio	River.
O 2,	2nd	"	"	"	"
O 3,	3rd	"	"	"	"

ILLUSTRATIONS.

RESERVOIR PROJECT VIEWS.

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HISTORY AND OBJECTS OF THE COMMISSION.

Historical — National Irrigation Movement — Forest Movement — Extension of Policy to Reservoirs — Activities of Chamber of Commerce in Forest Movement—Organization and Work of Flood Commission—Legislation.

HISTORICAL.

The regulation and control of the flow of navigable rivers in aid of interstate commerce is an important factor relating to the conservation, development and use of the natural resources of the United States, and the enlargement of its internal trade and commerce. When such a national policy has been adopted on a scale commensurate with the magnitude of the problem, it will not only promote navigation and water transportation, but must also necessarily include the storage of flood waters for flood prevention and for all other beneficial uses, and the protection of watersheds from denudation and erosion and from forest fires.

Much has already been done, in a disconnected and inadequate way, toward the inauguration of such a comprehensive national policy for river regulation; and the work done and measures advocated by the Flood Commission of Pittsburgh are in the direction of an ultimate enlargement of that policy which will be vastly beneficial to the entire country. The progress thus far made has been accomplished as the result of three organized movements.

First: The National Irrigation Movement, culminating in the passage of the National Irrigation Act, which became a Law on June 2, 1902. Under this act about sixty million dollars has been thus far expended in the construction of works for water storage and control in the western half of the United States. Several large reservoirs have been built on the headwaters of the Missouri River and its tributaries.

Second: The Appalachian Forest Reserve Movement, resulting in the passage of the Weeks Appalachian National Forest Act, which became a law on March 1, 1911. The purpose of this act as expressed in its title is "To enable any State to co-operate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of navigable rivers."

Third: The National Storage Reservoir Movement, which was first in order of date and was inaugurated by the Chamber of Commerce of Pittsburgh, through the National Board of Trade, in December, 1898. The resolution then presented by the Pittsburgh Chamber of Commerce to the National Board of Trade urged "the storage of flood waters on the upper branches of navigable streams, to be held in use for irrigation, for checking damaging floods and liberating water in times of drought that will preserve streams in navigable condition."

In behalf of this proposition, Mr. George H. Anderson, then Secretary of the Chamber of Commerce of Pittsburgh, submitted a report, the preamble of which was as follows:

"Your committee, to whom has been referred the subject of the storage of flood waters on the higher tributaries of the navigable streams in the Mississippi and Ohio valleys for improving navigation, providing for irrigation, etc., present the following report:"

After the discussion following the reading of this report, which is published on pages 59 to 76 of the Report of the 29th annual meeting of the National Board of Trade, held in Washington in December, 1898, and in Appendix No. 6 of this volume, a resolution was adopted by the National Board of Trade, embodying substantially the recommendations of the Pittsburgh Chamber of Commerce on this subject, and laying stress upon "the value of a system of improvement on the navigable waterways of the Mississippi and Ohio Basins for irrigating and making productive vast areas of arid lands, for the continued improvement of these rivers for transportation purposes and diminishing the destructive power of floods."

NATIONAL IRRIGATION MOVEMENT.

The movement thus started by the Pittsburgh Chamber of Commerce was taken up by the National Irrigation Association, organized on June 2, 1899, and brought about the enactment of the National Irrigation Act, previously mentioned. This association has persistently advocated the adoption of a national policy, which is stated in the constitution of the association as follows:

"The preservation and development of our national resources by the construction of storage reservoirs by the federal government for flood protection, and to save for use in aid of navigation and irrigation the flood waters which now run to waste and cause overflow and destruction."

A national educational propaganda was inaugurated, based upon the action of the National Board of Trade on the resolution of the Pittsburgh Chamber of Commerce, and also upon the recommendations of the Chittenden Report, Document No. 141, House of Representatives, 55th Congress, 2d Session. This report was made under an appropriation contained in the River and Harbor act of June 3, 1896, which provided, in Section 8, for a number of preliminary examinations, among which was the following:

"For the examination of sites, and report upon the practicability and desirability of constructing reservoirs and other hydraulic works necessary for the storage and utilization of water, to prevent floods and overflows, erosion of river banks and breaks of levees, and to reinforce the flow of streams during drought and low water seasons, at least one site each in the States of Wyoming and Colorado."

The Chittenden Report, transmitted to Congress on December 6, 1897, now out of print, has attracted wide attention, and may be found in part in the report of the Chief of Engineers of the United States Army, for 1898. An abstract of this report will be found in Appendix No. 6 of the Report of the Flood Commission. After a most exhaustive examination and consideration of the whole question of the effect and value of reservoirs to aid navigation, to prevent floods and to furnish water for irrigation, the following conclusions were stated:

"First. A comprehensive reservoir system in the arid regions of the United States is absolutely essential to the future welfare of this portion of the public domain.

"Second. It is not possible to secure the best development of such a system except through the agency of the national government."

The work of the Flood Commission of Pittsburgh has related primarily, of course, to the conditions on the headwaters of the Ohio River. It is worthy of note, at this point, that in considering the effect of flood water storage on the Missouri River upon floods in the lower Mississippi Valley, Colonel Chittenden said:

"The floods of the Mississippi are formed by the heavy rains in the low regions east of the ninety-eighth meridian, and very largely come from east of the Mississippi itself. The great controlling element, in fact, in all the lower river floods is the Ohio River."

The relation of flood water storage on the upper Ohio and its tributaries to river regulation and flood prevention in the Lower Mississippi Valley, is thus clearly set forth, and makes manifest the fact assumed in the resolution of the Pittsburgh Chamber of Commerce to the National Board of Trade in December, 1898, above referred to. Considered from a national point of view, flood water storage on the Ohio Basin is but one aspect of a great national problem, which is co-extensive with the entire drainage basin of the Mississippi River and all its tributaries, covering an area comprising more than one-third of the United States and stretching from Canada to the Gulf of Mexico, and from the crest of the Appalachian range on the east to the crown of the Continent on the west. Hence any attempt to localize the problem must fail.

In presenting the arguments, which make it clear that reservoir construction for river regulation is naturally and necessarily a national function, Colonel Chittenden, on pages 55 and 56 of his report, says:

"In the case of reservoirs it not infrequently happens that some of the very best sites are to be found close to State lines, where the waters so stored will flow immediately into neighboring States. In these extreme cases the States where they are located could not, of course, be ex-

pected to construct reservoirs, and the States to be benefited would not be likely to go outside their own borders to do so. The function clearly pertains to that sovereignty which covers all the country and embraces the streams from their sources to the sea. It alone can store these waters and be sure that it is reaping the full benefit.

"The policy of the Government in the matter of the preservation of the forests of the country is a case directly in point. There seems to be a well-nigh universal consensus of opinion that the preservation of the forests of the arid regions is distinctly a Government duty. * * * Inasmuch as the commercial value of these forests is practically insignificant, except for furnishing fuel and rough timber, the water question is really the more important one. If it is properly a Government function to preserve the forests in order to conserve the flow of the streams, surely it can not be less a Government function to execute works which will conserve that flow even more positively and directly. Granting all that can be said of forests in this connection, they certainly can never prevent the June rise, and it is precisely this waste flow which reservoirs will help to save. The forests ought unquestionably to be preserved, and the Government is the proper agency to do it, but the principal arguments therefore apply with accentuated force to the construction of reservoirs."

The precedent for the construction of reservoirs for river regulation and to reinforce the flow during low-water season, had already been established by the construction, beginning in 1881, of five reservoirs on the headwaters of the Mississippi River, where dams were built across the outlets of natural lakes. These reservoirs are described in Appendix No. 5 of this report and are referred to at some length by Mr. Anderson, in his paper mentioned above.

FOREST MOVEMENT.

The National Government has now, however, by the enactment of the Appalachian National Forest Bill, gone to the full extent of recognizing and using its constitutional power to control and regulate the flow of navigable rivers at their sources; not only by the building of artificial reservoirs but by preserving the forests and woodland cover on the watershed as natural reservoirs.

The maintenance and preservation of natural reservoirs by forest preservation, as provided in this act, and the construction of artificial reservoirs as advocated by the Flood Commission of Pittsburgh, on the headwaters of the Ohio River in the Appalachian Mountains, involve the exercise of a constitutional power, which is precisely the same in both instances. It is the same power which was exercised in the creation of the California Debris Commission, to prevent the silting up of navigable channels by the debris from hydraulic mines. It is also the same as exercised in the construction of levees on the lower Mississippi to aid in maintaining a navigable channel, notwithstanding the conceded fact that one of the greatest moving forces in that case was the necessity for protecting the plantations from overflow.

So, in the case of reservoir construction on the headwaters of the Ohio River, the constitutional power being so clearly established, the enormous damages by floods in the Ohio Valley, estimated to average at least $50,000,000 a year and in some years to be as high as $100,000,000, furnishes strong ground for relief from the national government; when it is conceded that such regulation of the flow of the river by reservoirs as would, beyond question, immensely aid navigation would also give relief from these destructive floods. Senator Burton clearly saw this aspect of the question when, in his speech in the senate on the passage of the Appalachian National Forest Bill, he said:

"Another thing that the Federal Government ought to do *if this precedent is established,* and it ought to do it *right away,* is to provide means for the prevention of floods. At certain seasons of the year we can hardly take up a newspaper without reading of the loss of life and of the mammoth destruction of property as a result of floods in the Ohio, the Mississippi, and various other streams of the country. Those floods have a direct influence upon navigation. If we are going to inaugurate this policy, why not protect these manifold interests by preventing floods and save the tremendous loss of property and the very pitiful loss of life which so frequently occurs?"

EXTENSION OF POLICY TO RESERVOIRS.

The national government having, by the passage of the Appalachian National For-

est Act, inaugurated the policy of maintaining natural reservoirs on the tributaries and source streams of the navigable rivers, for the purpose of regulating their flow, and having extended the policy of National Forest Reserves for that purpose into the Appalachian Region, it is manifest that even-handed justice between the different sections of this great country requires that the policy of building artificial reservoirs for river regulation should also be extended over that portion of the United States lying east of the Mississippi River. Thus far, everything done under that constitutional power, for the control and regulation of the flow of the navigable rivers, has been on the headwaters of the Mississippi River, or in the lower valley of that river, or in the vast territory to the west of it. The entire territory extending from the Mississippi River on the west to the Atlantic sea coast on the east has been excluded from any local participation in the benefits of expenditures under that policy.

The Flood Commission of Pittsburgh now urges that the policy already inaugurated in a part of the country be made broadly national, and that the east as well as the west shall be made beneficiaries under it. The Chamber of Commerce of Pittsburgh has at all times, from the very first, been an active and consistent advocate of the reservoir policy in the west, and now with the same broad vision of national benefits, the Flood Commission, organized by the Chamber of Commerce, urges its extension to the east. All who advocate national irrigation in the west, national drainage in the south, or flood prevention in the east through national river regulation, are practically supporting one and the same national policy, and should unite to accomplish its nation-wide adoption.

Pittsburgh took the lead in urging this broad application of the policy as far back as 1898, and has aided other sections to secure the first benefits from its adoption. It is therefore peculiarly appropriate that Pittsburgh, after spending over $100,000 to establish the facts and showing the practicability and necessity for the adoption of the same constructive national policy in the Ohio Valley, should take the lead in a national campaign to extend the national policy of flood water storage over the entire United States, and to all navigable rivers and their tributaries and source streams.

A bill providing for such a broad national extension of the policy of river regulation was introduced by Senator Newlands in the Senate of the United States, on March 1, 1911, the day the Weeks Appalachian National Forest Bill became a law by the signature of the President. The purpose of this Newlands River Regulation Bill was to so enlarge the forest policy inaugurated by the Weeks Bill as to make it cover the entire United States, and to supplement the establishment and maintenance of the natural reservoirs, which the forests and woodland cover create, by an adequate national system of artificial reservoirs for flood water storage. This bill, which is printed in Appendix No. 6 of this volume, was Senate Bill 10900, in the 61st Congress, 3rd Session, and Senate Bill No. 122, in the 62nd Congress, 1st Session.

The Chamber of Commerce of Pittsburgh has in the past supported both the National Irrigation Act, which was known as the Newlands Bill in the House of Representatives when it passed that body, and the Weeks Appalachian National Forest Act; and has extended its endorsement and support to the Newlands River Regulation Bill, by the adoption, on April 13, 1911, of the following Resolution:

WHEREAS, a bill was introduced in the Senate of the United States by Senator Newlands, on March 1st, 1911, entitled:

A bill to create a Board of River Regulation and to provide a fund, for the regulation and control of the flow of navigable rivers in aid of interstate commerce, and as a means to that end to provide for flood prevention and protection and for the beneficial use of flood waters and for water storage, and for the protection of watersheds from denudation and erosion and from forest fires, and for the co-operation of Government services and bureaus with each other and with States, municipalities and other local agencies; and

WHEREAS, the primary purpose of said bill is to bring into conference and co-operation

the National Government with the States, Municipalities, Counties and local districts for the construction of the works necessary for the regulation of the flow of rivers and for flood prevention and protection, and it provides a fund of $50,000,000 annually for ten years for said purpose; and

WHEREAS, the passage of said bill by Congress would result in the relief, not only of Pittsburgh, but of all cities and communities on the Ohio, Missouri and Mississippi Rivers from destructive floods, and increase the flow of the rivers in the low water season for navigation;

NOW THEREFORE BE IT RESOLVED, that the Chamber of Commerce of Pittsburgh hereby endorses said Newlands River Regulation Bill and requests the Senators and Congressmen from this State to urge its passage by Congress.

ACTIVITIES OF CHAMBER OF COMMERCE IN FOREST MOVEMENT.

The Chamber of Commerce of Pittsburgh has for many years taken an active interest in the subject of forest reserves along the headwaters of the important Appalachian streams. As early as January 8, 1903, a resolution was unanimously adopted petitioning the Congress of the United States to provide for the establishment of a National Forest Reserve in the Southern Appalachian Region with a special view to the protection of the sources of the southern tributaries of the Ohio River.

On January 13, 1907, the Chamber was addressed by Mr. William L. Hall, in charge of the Appalachian and White Mountain Investigation, for the Forest Service of the U. S. Department of Agriculture, on the subject of Forest Reserves, and especially the desirability of such at the headwaters of our rivers, for preventing floods and for assisting in maintaining a supply of water in our rivers in the dry seasons. At the conclusion of the meeting, a resolution, presented by Captain W. B. Rodgers, for the Committee on Rivers and Harbors, was adopted, to the effect that the Chamber request cooperation by the Pennsylvania State Forest Reservation Commission with the Federal authorities in the examination of the watershed of the Ohio River.

At the regular meeting of the Chamber, held on January 9, 1908, Mr. William L. Hall, of the Forestry Service, was again present and addressed the meeting upon the results of his investigation, which had been made into the needs for forest reservations in the territory at the headwaters of the Monongahela River. He displayed maps and charts, showing the land which it was deemed advisable should be reforested, basins which could be made available as reservoirs, etc.

On January 30, 1908, the Chamber was represented before the House Committee on Agriculture, of Congress, by delegates, in support of House Bill No. 14056. In brief, this bill provided for acquiring national forests in the Southern Appalachian and White Mountains. This measure was later known as the Weeks Bill, which became a law March 1, 1911. Their report to the Chamber is included as a part of Appendix No. 6 of this volume. On March 12, 1908, Hon. Gifford Pinchot, Chief of the Forestry Division of the Department of Agriculture, was present and made an interesting address on the subject of forestry.

A special meeting of the Board of Directors was called for March 24, 1908, to consider and take action upon resolutions expressive of the interest of the Chamber of Commerce of Pittsburgh in a conference which President Roosevelt had called, to be held at the White House, on May 13, 1908, for the purpose of considering the subject of the conservation of the national resources of the United States. Resolutions were presented expressing the interest of this Chamber in the conference, and urging that the State of Pennsylvania be well represented at the conference.

On January 25, 1911, a letter was received by the Chamber of Commerce, from those in charge of the campaign for the passage of the Weeks Bill, making a most earnest appeal for immediate and active support for the bill in the Senate. A repre-

sentative of the Flood Commission thereupon went to Washington and remained there working for the passage of the bill until it finally became a law.

ORGANIZATION OF FLOOD COMMISSION OF PITTSBURGH.

The Flood Commission of Pittsburgh was organized to ascertain the damages by floods at Pittsburgh, to investigate the cause of these floods, and to determine the nature and the cost of the best method of relief. The Commission had its origin in a resolution adopted by the Chamber of Commerce of Pittsburgh, on February 20, 1908.

This resolution, which marked the first definite action toward solving the flood problem, was presented by Col. Albert J. Logan as an amendment to the report of the delegates who had appeared before the House Committee, January 30, 1908, in support of Bill No. 14056, referred to above; and as a substitute for one introduced by George M. Lehman, providing for the appointment of a committee of three to investigate "the monetary loss, character of damage and areas affected by the floods in the Pittsburgh District, and secure such other information as may be of value as a basis for further consideration of plans for improvement."

There were other attending influences, notably letters addressed to the Secretary and President of the Chamber of Commerce, which letters, as well as the report of the committee of delegates above referred to, appear in Appendix No. 6 of this volume. The resolution, which was accepted and adopted, was as follows:

"WHEREAS, the frequent high stages of water causing our rivers to overflow their banks and resulting in great damage to property, producing sickness and suffering for many of our citizens; and

"WHEREAS, the limited territory of reasonably level land in the manufacturing, commercial and railroad terminal sections of our city is almost all subject to being overflowed, especially should a slight increase in floods occur over what we have heretofore suffered;

"THEREFORE BE IT RESOLVED, that the President be instructed to appoint a Special Committee of seven, whose duty it shall be to suggest a plan or plans by which some practical means may be had to protect the city from floods. They to have power to add to their numbers, elect their own officers and raise funds to prosecute the work assigned to them."

The flood committee, appointed by the President of the Chamber of Commerce, consisted of the following:

"A. J. Kelly, Jr., Morris Knowles, C. E., Col. A. J. Logan, George M. Lehman, C. E., H. J. Heinz, H. M. Brackenridge and Capt. W. B. Rodgers."†

WORK OF COMMITTEE.

The committee organized by the selection of the following officers: H. J. Heinz, chairman; George M. Lehman, secretary. A fund of $3,000 was created to carry out the investigations of this committee, and the work was immediately begun.

One of the first steps taken by the committee was to add new members and to appoint a sub-committee of three members, to determine the engineering problems likely to be involved in the investigation. This sub-committee, which was composed of H. J. Heinz, Lieut. Col. H. C. Newcomer,* Corps of Engineers, U. S. Army, and George M. Lehman, C. E., reported, March 20, 1908, in part as follows:

"In accordance with the request for a report upon the mode of procedure and funds required for the work of investigation of flood protection for this community, your Engineering Sub-Committee is of the opinion that the work should be prosecuted under the following general headings:

1. Forestation of watersheds.
2. Storage reservoirs on watersheds.
3. Elevation or filling in of ground subject to overflow.
4. Dike or wall protection along the rivers.

The third and fourth methods offer the only practicable means of relief that are wholly within the control of the local community, and possible of execution within reasonable time.

Some relief would possibly result from reforestation of the watersheds and decided relief might be secured by construction of reservoirs if found possible on an adequate scale These two methods, however, would require the co-operation of local, state and federal government, and cannot offer the speedy relief that is so urgently needed. Nevertheless, the practicable limit of their appli-

*Lieut. Col. Newcomer resigned December 1, 1908. †Capt. Rodgers resigned April 19, 1911.

cation could be investigated, and the results of such investigation included in the Committee's final report to the Chamber of Commerce." * * *

The first actual work of the committee was to ascertain the extent of the damages in the record flood of 1907. From this preliminary investigation, it developed that the problem of flood relief was so extensive, and its successful solution so vital to the prosperity and proper development of Pittsburgh, that an exhaustive study of the whole question was warranted. It was found, for example, that in the 1907 flood, an area of approximately 1600 acres was directly affected by overflow, and a very considerable additional area affected indirectly by seepage; that this area included real estate to the extent of about $160,000,000 assessed valuation; that numerous manufacturing plants were obliged to suspend operations; that the heart of Pittsburgh's financial district was penetrated and many of the important office buildings in the business section were deprived of light and power; that numerous poor families were rendered homeless and their household goods destroyed; that 34 miles of streets, 17 miles of railroad tracks and 9 miles of street car tracks were submerged; and finally that, had the flood risen six inches higher, the main pumping station would have been put out of commission and the entire city left without water for domestic and fire protection purposes.

FORMATION OF FLOOD COMMISSION.

It was decided at this time to enlarge the committee, and a Flood Commission was formed, composed of 34 members of the Chamber of Commerce, business men, engineers and other professional men. The work of the Commission was subdivided by the formation of the following committees: Executive, Finance, Engineering, Real Estate, Sewage Disposal, Legislation, Publicity and Rules and Membership. The Engineering Committee was subdivided into two branches, Flood Protection and Flood Prevention. A year ago the Commission was further enlarged by the addition of the City and County officials, and by the addition of manufacturing and business concerns in the Pittsburgh District, affected directly or indirectly by floods.

WORK OF FLOOD COMMISSION.

The first problem which confronted the Commission was the raising of sufficient funds to defray the expenses of the investigations. It was decided that the owners of property actually affected by floods be asked to contribute at the uniform rate of one mill on the dollar of the assessed valuation. The Chamber of Commerce contributed $1,000 as a preliminary fund. Property holders and others, up to February 1st, 1912, had contributed about $57,000, in amounts ranging from $4 to $5,000. At a meeting of the Executive Committee of the Flood Commission, at which Mayor George W. Guthrie and Controller E. S. Morrow were present, it was arranged that the City of Pittsburgh should contribute $10,000 in 1909, only about $7,500 of which was used. During the administration of Mayor William A. Magee, contributions were made of $14,000 in 1910, $10,000 in 1911, and $20,000 in 1912. Under a special act of assembly the County of Allegheny in 1911 contributed $7,500. A fund of $6,990 was received through membership contributions. This makes a total of approximately $124,000, which has largely been expended in carrying on the extensive surveys, investigations, publicity campaign and constructive campaign of the Commission.

The engineering work of the Commission has included detailed surveys and soundings of the three rivers within the city limits, and from these data a set of maps has been prepared, showing on a large scale the present conditions and developments along the rivers and the extent of the flooded area. In connection with these surveys, a system of

precise levels was carried out and permanent bench mark plates placed in various parts of the city. Studies have been made of the cost and effectiveness of dredging, straightening and widening the river channels for the purpose of reducing flood heights. The question of a river wall has been thoroughly investigated, both as to location and necessary height and as to cost.

Studies of precipitation and stream-flow have been made at numerous points on the two drainage basins. Part of the stream measurement work has been conducted in co-operation with the Water Supply Commission of Pennsylvania. The stream gagings are still being carried on, in order to obtain the most complete knowledge possible of the regimen of the various tributaries. Through co-operation with the Forest Service of the Department of Agriculture and with the Pennsylvania Department of Forestry, a field investigation of the conditions and amount of forest cover and of agricultural development on the two drainage basins has been made.

For the purpose of ascertaining the feasibility of preventing floods by means of storage reservoirs, extensive surveys have also been made of numerous reservoir sites scattered over the drainage area of about 19,000 square miles above Pittsburgh. The selection of these sites was based on a reconnoissance including every tributary of over 50 square miles drainage area. From these surveys contour maps on a large scale were plotted and estimates made of the capacity and cost of the reservoirs. Exhaustive studies were then made of the combined and relative effect of these reservoir projects in reducing floods at Pittsburgh and at other points along the main rivers and their tributaries. It was found, moreover, that a certain part of the impounded flood water could safely be retained in these reservoirs until times of low water, and then released to maintain a uniform low-water flow several times the present minimum. This led to a careful study of the resultant benefits to navigation, sanitation and water supply and of the possibility of water power development.

At the beginning of the Flood Commission's studies, it was believed by the engineers that the subject was one local to Pittsburgh and they prepared to treat it as such. As the investigations developed, it became evident that the flood problem was not peculiar to Pittsburgh, but that Pittsburgh's floods had a direct bearing upon the flood troubles of other communities. Further study disclosed the fact that inseparable from the flood problem was the question of navigation; that the high water at certain periods of the year bore a close relation to low water at other periods. The problem thus became national in scope and is treated as such in this report. On two occasions during the progress of the Flood Commission's study, the work done by its engineers engaged the attention of the national law makers, who were profoundly impressed with the plans of the Commission from a federal standpoint.

PRELIMINARY REPORT OF ENGINEERING COMMITTEE.

Before undertaking a study of the question, the Engineering Committee, on February 18, 1909, issued a statement signed by E. K. Morse, Emil Swensson, Paul Didier, W. G. Wilkins A. B. Shepherd,* Julian Kennedy, S. C. Long,† George M. Lehman and Morris Knowles. This statement read as follows:

"The Flood Commission, which was appointed by the Chamber of Commerce of Pittsburgh, for ascertaining remedial measures necessary for the avoidance of the enormous damage and suffering from floods, so frequently occurring to this city, presents to the public the mode of procedure for the investigations, as recommended by the Engineering Committee of the Commission.

"The Engineering Committee, at the request of the Flood Commission, have obtained, through the courtesy of the Secretary of State, Washington D. C., over two hundred reports from U. S. Consuls in foreign countries, bearing on the subject of flood prevention and flood protection. Many of these are technical reports, made by flood commissions appointed by the various governments,

*Mr. Shepherd resigned February 6, 1911. †Mr. Long removed to Philadelphia and resigned March 14, 1911.

and contain much information as to methods used and proposed in those countries. These reports will receive thorough study by the Engineering Committee, to determine whether any of them are applicable to conditions in the Pittsburgh district.

"Maps have been made, showing the flooded area of the city, which covers about sixteen hundred acres, and a schedule has also been prepared, from an actual canvass of the affected districts, of the amount of damages caused by these floods, as follows: March 15, 1907, when the height reached was 35.5 feet; February 16 and March 20, 1908, with heights of 30.7 and 27.3 feet, respectively. In round numbers the amount of direct damage caused by these three floods was four million dollars, so far as ascertained, but the total loss, direct and indirect, will vastly exceed this figure, as the Commission has not yet received complete returns from property owners.

"After a careful review of the flood conditions in Europe, so clearly outlined in the reports already received, and personal experience with the damage sustained yearly by the ever increasing floods in Pittsburgh, we are convinced that this great subject must be dealt with in its entirety; that it will be impossible to intelligently design a wall around the city without all the facts; as it is necessary to completely and at all times keep out the flood waters, and at the same time design a wall that will be of no greater height than necessary and at the least possible cost to the city.

"The Engineering Committee believe it would not be doing its full duty to the Commission, or to the citizens of Pittsburgh, if it does not thoroughly consider every possible means for prevention of floods, which are bound to occur from time to time, or the lowering of their heights.

"In the study of the problem the Engineering Committee propose to consider the following subjects and their bearing on its solution:

1. Walls or dikes.
2. Elevation, or filling in of ground subject to overflow.
3. Deepening and correction of navigable parts of the river channel.
4. Storage reservoirs.
5. Forestation of watersheds and any other means that may seem practicable.

"Until a thorough investigation has been made, it is, of course, impossible to determine which of the above plans will give the needed results, or what combination of them may be necessary to accomplish the desired result."

LEGISLATION.

At the beginning of the year 1911, when the engineering work of the Commission had reached a point where the prevention of floods was known to be feasible, it was decided that steps should be taken toward having the recommendations of the Flood Commission carried into effect by legislative action.

A representative of the Flood Commission was sent to Washington and a provision was embodied in the River and Harbor bill, which passed the last regular session of Congress, authorizing an investigation of Pittsburgh's flood problem by the National Waterways Commission. This Commission visited Pittsburgh on April 17, 1911, and on that day a hearing was held at the Chamber of Commerce of Pittsburgh, at which an outline of the plans of the Flood Commission was presented. (See Appendix No. 6). On the following day, the National Waterways Commission, accompanied by the Engineers and Committees of the Flood Commission and Chamber of Commerce, made a trip to Parker, on the Allegheny River, where they inspected the site of the dam for one of the proposed storage reservoirs, near the mouth of the Clarion River.

The Flood Commission and Chamber of Commerce of Pittsburgh, as has been previously set forth, supported the Appalachian bill, which passed Congress at the last regular session. This bill carried an annual appropriation of $2,000,000 for the acquisition of forest reserve lands in the Appalachian states. The Flood Commission had selected and surveyed many available reservoir sites in Pennsylvania, West Virginia and Maryland, and was desirous that the selections of the lands purchased under this act should be so made as to include the proposed sites. The Appalachian bill contained a proviso that before any such lands could be purchased, the consent of the state must first be secured. West Virginia and Maryland had passed such a law, but Pennsylvania had done nothing. The Flood Commission thereupon held a conference with the State Water Supply Commission and the State Forestry Department, and an enabling act was agreed upon, which was thereafter introduced in the Pennsylvania Legislature. This act was passed through the efforts of the Flood Commission.

Looking forward to the time when the cooperation of the counties in Pennsylvania affected by floods would be necessary in the construction of works for flood relief, the Flood Commission had a bill drafted enabling counties to borrow and expend moneys for this purpose, and also to enter into contracts with each other, or with the State, or with the United States, for the purpose of carrying out the necessary works. This bill likewise became a law.

The publication of this report by the Flood Commission, with its numerous maps, diagrams and halftones, entailed the expenditure of a large sum of money. The County Commissioners and County Controller expressed a willingness to have Allegheny County defray the expense of this publication. It was found, however, that no authority existed, enabling the County to contribute to the work of the Flood Commission. The Commission therefore had an act prepared, conferring this authority upon the County, which was passed at the last session of the State Legislature. By authority of this act the County of Allegheny, under resolution passed by the Commissioners, agreed to contribute $10,000 in 1912, for the expense of preparation and publication of this report.

CHAPTER I.

RESULTS OF INVESTIGATIONS.

Findings and Recommendations—Main Features of Reservoir Projects—River Wall—Channel Revisions at Islands—Comparison of Net Cost of Schemes—Scheme Finally Adopted—Comparison of Cost and Benefits.

FINDINGS AND RECOMMENDATIONS.

The investigations and surveys of the Flood Commission of Pittsburgh, and studies based thereon, as fully described in the succeeding chapters of this report, enable the Commission to make the following statements:

1. Floods at Pittsburgh are increasing in frequency and height.

2. It is not improbable that Pittsburgh will some day experience a *forty-foot flood.*

3. The damage resulting from a flood of a given height is steadily increasing.

4. The direct losses due to flood damage at Pittsburgh amounted to over $12,000,000 in the last ten years, while in one year and five days, between March 15, 1907 and March 20, 1908, three floods occurred, causing a direct loss at Pittsburgh of about $6,500,000.

5. If works for flood relief are not carried out, the direct losses due to flood damage at Pittsburgh alone will, on a conservative estimate, amount to $40,000,000 in the next twenty years.

6. The flood losses along the Ohio Valley in one year, 1907, are stated in the preliminary report of the Inland Waterways Commission for 1908 to have amounted to over $100,000,000.

7. Flood relief by some form of local protection only, *without storage reservoirs,* cannot be recommended because:

(a) Such protective measures would give local relief only.

(b) Such local relief would be the only benefit derived.

(c) Dredging alone, without reservoirs, would not reduce floods sufficiently, and a wall would still have to be built.

(d) The wall, without reservoirs, would have to be too high and would be too costly.

8. The flood water that would otherwise cause damage can be impounded in storage reservoirs, and by this means floods can be prevented.

9. There are many favorable reservoir sites of large capacity available for flood water storage on the drainage areas above Pittsburgh.

10. Forty-three sites have been selected and most of them completely surveyed by the Flood Commission, the others having been studied from existing topographical maps and by means of partial surveys.

11. From a study of the relative effectiveness of the various projects it was determined that adequate flood reduction at Pittsburgh could be obtained with twenty-eight of these reservoirs, while a final analysis reduced the number to seventeen.

12. If the Seventeen Selected Projects above referred to had been in operation,

without any wall, the storage of flood water in these reservoirs would have reduced all past Pittsburgh floods to below the danger mark, or 22-foot stage, with the exception of the great flood of March, 1907, which would have been reduced from a stage of 35.5 feet to a stage of 27.6 feet.

13. Supplementing the Seventeen Selected Projects by a wall along the low-lying portions of the river bank would confine all floods, *including a possible forty-foot flood,* within the river channels.

14. Flood prevention by storage reservoirs is possible and practicable, and is recommended because:

(a) The flood relief would be extended over hundreds of miles of tributaries and of the main rivers, including the Ohio for many miles below Pittsburgh.

(b) The impounded flood water, with proper manipulation of the reservoir system, would considerably increase the low-water flow of the tributaries and of the main rivers.

(c) This increased low-water flow would greatly aid navigation and interstate commerce.

(d) The increased low-water flow would notably improve the quality of the water for domestic and industrial purposes.

(e) The sewerage problem of Pittsburgh and of many other communities along the rivers would be simplified.

(f) The public health would be protected against the dangers arising from the unsanitary conditions caused by overflow and by extreme low water.

(g) A considerable amount of water power would be incidentally developed.

15. The solution of the flood problem therefore becomes of great importance to other communities along the river, and to the Counties and the State, and also, because of the benefits to navigation, to the National Government.

16. Reservoirs for flood control have been built in other countries, and have been so successful, both in preventing floods and improving the low-water flow and navigability of the rivers, that other large works of this kind are now under construction and many more are contemplated.

17. Prevention of Pittsburgh floods by storage reservoirs has in the past been pronounced possible by a number of eminent engineers. It has generally been thought impracticable because of the cost, but these opinions as to cost were not in any case based on actual surveys, designs and estimates.

18. The estimates of the cost of storage reservoirs and other works for flood relief made by the Flood Commission are based on detailed surveys, and show that Pittsburgh can be completely safeguarded against floods at a cost of about $20,000,000.

19. The Commission urges the carrying out of the proposed works for flood relief at the earliest possible date. The expenditure of this sum of $20,000,000 is warranted for the following reasons:

(a) Had this expenditure been made, so that the benefits therefrom would have been realized through the past ten years, more than half the amount would have been saved by prevention of the flood damage at Pittsburgh alone.

(b) The cost is but one-half the direct loss, amounting to $40,000,000, that it is estimated will otherwise be caused by flood damage at Pittsburgh in the next twenty years.

(c) The large area affected by floods in Pittsburgh includes real estate having an assessed valuation of $160,000,000. If relieved from the flood menace, this prop-

erty would be increased in value at least $50,000,000, or more than twice the cost of the necessary flood relief measures.

(d) The cost is small considering the total loss by flood damage in a few years, in all the districts that would receive benefits from flood relief.

(e) The flood losses along the Ohio Valley in one year, 1907, are stated to have amounted to over $100,000,000. The proposed reservoir system would completely relieve the upper Ohio from damaging floods, and reduce their height and damage for a considerable distance downstream.

(f) The expenditure of the sum necessary upon the Allegheny and Monongahela Rivers would be the important beginning of the construction of a comprehensive reservoir system upon all tributaries of the Ohio River. Such an extension of the system would prevent floods throughout the entire Ohio Valley.

(g) The reduction of the maximum and the increase of the minimum flow of those streams that are now navigable for any portion of the year would greatly improve the traffic opportunities upon them. At the maximum height the current would be greatly reduced, the clearance under the bridges increased, and access to landings easily obtained. During the lowest stages there would be an increase in depth over present conditions.

(h) The annual saving due to the improved quality of the water for domestic and industrial uses, and the prevention of damage resulting from chemical impurities in the water, at low stages of the streams, would, in itself, warrant the expenditure of a considerable portion of the cost of the proposed flood prevention.

(i) The water power that would be developed could be utilized to produce electrical energy, and thereby yield a revenue that would cover the cost of maintaining and operating the reservoir system and, in addition, render a return upon the investment.

RIVER WALL.

The main features of the wall proposed in combination with reservoir control are as follows:

Total length	23,830 feet
Height (maximum)	30 feet
Height (minimum)	9 feet
Height (average)	14 feet
Average cost per running foot	$ 28
Total cost	667,200
Value of reclaimed land	584,000
Net cost	83,200

CHANNEL REVISIONS AT ISLANDS.

The above figures are for the wall that would be required if the location following the natural bank line throughout should be used. As fully described in Chapter VIII, however, it was found that the elimination of the back channels at Six Mile, Herr and Brunot Islands would improve the river channels, and at the same time reclaim such considerable areas of valuable land that the net cost of the scheme would be less than with the wall following the natural bank line throughout. In the following comparison of the net cost of schemes, which gives the cost of the recommended method of flood relief, namely the construction of the Seventeen Selected Projects and of the river wall to be used in combination therewith, the cost is therefore given for each of these wall locations.

TABLE No. 1.
SUMMARY OF MAIN FEATURES OF VARIOUS GROUPS OF RESERVOIRS.

Drainage areas, capacities, costs, etc.	43 Projects			28 Projects			17 Projects		
	Allegheny Basin	Monongahela Basin	Combined Basins	Allegheny Basin	Monongahela Basin	Combined Basins	Allegheny Basin	Monongahela Basin	Combined Basins
Total drainage area controlled, (sq. miles)	8,454	3,379	11,833	8,253	2,511	10,764	8,023	2,159	10,182
Total drainage area controlled, (per cent)	73	46	62	71.3	34.2	56.8	69.2	29.5	53.8
Total capacity, (mill. cu. ft.)	49,725.8	30,772	80,497.8	48,603.2	23,969.9	72,573.1	42,178.5	17,302.9	59,481.4
Total cost of dams and appurtenances, (dollars)	11,336,200	9,026,800	20,363,000	10,506,600	4,847,800	15,354,400	8,077,700	3,101,200	11,178,900
Cost per million cubic feet capacity, (maximum), (dollars)	2,155	2,109	2,155	597	609	609	326	400	400
Cost per million cubic feet capacity, (minimum), (dollars)	136	82	82	136	82	82	136	94	94
Cost per million cubic feet capacity, (average), (dollars)	228	293	253	216	202	211	191	179	188
Total land area submerged, (including marginal strip) (acres)	26,826	17,094	43,920	26,039	12,809	38,848	20,860	7,429	28,289
Total cost of land submerged, (dollars)	1,038,800	390,500	1,429,300	980,300	329,700	1,310,000	848,500	238,500	1,087,000
Average cost of land submerged, per acre, (dollars)	39	23	33	38	26	34	41	32	38
Total cost, including damages, etc., (dollars)	21,531,900	12,638,900	34,170,800	20,479,800	7,599,900	28,079,700	16,851,800	4,820,300	21,672,100
Cost per million cubic feet capacity, (maximum), (dollars)	2,611	2,449	2,611	857	838	857	719	646	719
Cost per million cubic feet capacity, (minimum), (dollars)	210	112	112	210	112	112	210	224	210
Cost per million cubic feet capacity, (average), (dollars)	433	411	424	420	316	386	400	279	364
Total maximum capacity, (mill. cu. ft.)	54,082.8*	48,709.5	102,792.3*	51,029.7	36,034.9	87,064.6	43,555.4	26,299.8	69,855.2
Excess above flood control capacity, (mill. cu. ft.)	4,357*	17,937.5	22,294.5*	2,426.5	12,065	14,491.5	1,376.9	8,996.9	10,373.8

*Including Clarion No. 2.

Note. All figures in above table, except those opposite last two items, are for flood control capacity.

COMPARISON OF NET COST OF SCHEMES.

(Using 17 selected reservoirs and low wall.)

(1)	With wall along natural bank line throughout	$21,755,300
(2)	With wall modified to eliminate back channels	20,035,100
	Difference in favor of (2)......................	1,720,200

SCHEME FINALLY ADOPTED.

This comparison leads to the final conclusion that the best method of flood relief is the construction of seventeen selected storage reservoirs, supplemented by a river wall at Pittsburgh eliminating the back channels at the three islands, at a total net cost, in round numbers, of about $20,000,000.

COMPARISON OF COSTS AND BENEFITS.

The following table enables a ready comparison of the cost of the recommended method of flood relief with the direct benefits to be derived, insofar as figures are available. It has not been possible to obtain similar values for flood relief to communities other than Pittsburgh. A study of the extent of this flood relief, however, as shown in Chapter IX, which treats of the effect of storage reservoirs on the flow of the rivers above and below Pittsburgh, will make it evident that the addition of these figures, if available, would enormously increase the above total value of benefits. It is evident also, that to these benefits should be added, if it were possible to reduce them to an approximate money value, the benefits to navigation and the value of water power, which are described in Chapters X and XII.

TABLE No. 2.

COMPARISON OF COST AND BENEFITS OF FLOOD RELIEF.

Net cost		Benefits	
17 reservoirs and river wall........	$20,000,000	Estimated flood damage at Pittsburgh in next 20 years..........	$40,000,000
Maintenance and operation, ($200,000 capitalized @ 5%).....	4,000,000	Increase in value Pittsburgh real estate in flooded district..........	50,000,000
		Improvement of water for domestic and industrial supply...........	6,000,000
Total	$24,000,000	Total	$96,000,000

CHAPTER II.

ALLEGHENY AND MONONGAHELA DRAINAGE BASINS, AND OHIO RIVER.

Combined Basins—General Location—Topography—Drainage—Geology—Coal—Oil and Gas—Glaciated Area—Forest Cover—Precipitation—Discharge — Temperature—Developments — Navigation—Rivers—Canals — Railroads — Industrial Developments — Population — Allegheny River—Monongahela River—Ohio River.

COMBINED BASINS.

GENERAL LOCATION.

The Allegheny and Monongahela Rivers form the headwaters of the Ohio River and join at the City of Pittsburgh. The area drained by the two rivers lies in a northerly and southerly direction, and covers practically the western third of the State of Pennsylvania. The extreme northern end of the basin is in the southwestern corner of New York State, thirty miles south of the City of Buffalo, and at one point the watershed is only four miles distant from the edge of Lake Erie. The southern end involves the northeastern part of West Virginia and the northwestern corner of Maryland.

The Allegheny and Monongahela drain areas of 11,580 and 7,340 square miles respectively, or a total of 18,920 square miles. The distribution of the combined basins, in per cent of area, is as follows: New York, 10; Pennsylvania, 66; West Virginia, 22; Maryland, 2. The area of the basins lying in Pennsylvania is equal to 27.5 per cent of the total area of the state. The basins have a greatest length of 290 miles, an average width of about 65 miles and a least width of 46 miles, across the Allegheny at Kittanning. The combined area is equal to 9 per cent of the total area of the Ohio Basin, which is 210,000 square miles.

TOPOGRAPHY.

The Allegheny and Monongahela Rivers, including with the latter the Tygart Valley River, practically mark the dividing line between the mountainous Appalachian country and the wide and much lower table land which slopes gradually westward to the Mississippi River, about 600 miles distant.

The principal rivers flowing from the outside slopes of the basins are as follows: On the northeast, in Pennsylvania, the Genesee, which enters New York State and joins Lake Ontario; along the middle east and southeast, the Susquehanna and Potomac, both draining into the Atlantic Ocean; from the southeast and south, the Big Kanawha, which enters the Ohio 265 miles below Pittsburgh. The Beaver River, which enters the Ohio from the north 26 miles below Pittsburgh, drains the country immediately west of the Allegheny watershed.

At the southeastern line of Randolph County, West Virginia, where the watershed is 4400 feet above tide, and where it turns northwest from one of the ranges of the Alleghenies, the sources of three rivers lie within a range of less than half a mile. One of these streams is the Dry Fork, a branch of the Cheat, which in turn empties into the Monongahela, and the other two are the Potomac and Kanawha. The upper part of the James River is about 14 miles to the east.

Pittsburgh from Duquesne Heights showing confluence of Allegheny and Monongahela Rivers.

The rim of the combined basins is considerably lower on the west side, particularly upon nearing Pittsburgh from the north and south. The averages of the higher elevations are as follows: Allegheny River, west side, 1330 feet, east side, 2275 feet; Monongahela River, west side, 1950 feet, east side, 3800 feet.

In the extreme northwestern portion of the basin, around the headwaters of the Allegheny, the topography is a broken plateau, with the higher parts averaging about 2200 feet or over. In this region it is found that nearly 1500 square miles, or 8 per cent of the combined basin area, is above an elevation of 2000 feet. The greater part of the country between Kinzua Creek valley and the Conemaugh River is under 2000 feet, the higher elevations of portions not exceeding 1500 feet. The very high country begins at the head of the Kiskiminetas and extends in the eastern side of the basins for a width of about 30 miles to the southern end. In this region, about 14 per cent of the combined basin area lies above an elevation of 2000 feet, slightly over 3 per cent above 3000 feet, and 1 per cent above 4000 feet.

The main ridge of the Allegheny Mountains is situated about 30 miles to the southeast of the source of the Allegheny and, following the southwesterly trend of the general mountain system, joins the watershed line of the basins northeast of Johnstown, at the head of the Conemaugh tributary. From here, with elevations of nearly 3000 feet, it forms the rim of the basin nearly to the Maryland state line, finally entering the basin and converging with Negro or Hoops Mountain, northeast of Oakland, in Maryland. A short distance to the south, Hoops Mountain runs out, becoming involved in the irregular mass of the hills to the southwest.

Probably the most persistent range in the basins is the Laurel Ridge, with a full length of 150 miles, which has its beginning a short distance north of the Conemaugh River, crosses that stream a few miles west of Johnstown, and then crosses the Youghiogheny west of Confluence and the Cheat River just to the west of Rowlesburg, W. Va., after it has passed along a part of the West Virginia-Maryland state line. This ridge has the name of Rich Mountain south of Tygart River, which it crosses west of Elkins. It terminates at Mast Knob, elevation 4000 feet, on the watershed at the head of the Buckhannon River. The next range to the northwest is the Chestnut Ridge, which also has its beginning a short distance to the north of the Conemaugh valley and crosses that valley to the east of Blairsville, the Youghiogheny to the east of Connellsville and the Cheat River at Mont Chateau, coming to an end, or disappearing as a distinct ridge, a short distance to the south. This range has a length of about 75 miles.

Savage Mountain, in Pennsylvania, the next ridge to the southeast of the main Allegheny, forms a short part of the watershed at the Pennsylvania-Maryland state line, and a longer part of the watershed south of Oakland. It enters the basin northeast of Parsons, with the name of Backbone Mountain, which changes to McCowan Mountain along the eastern side of the Cheat River, and then to Cheat Mountain, after it crosses to the west side of Shavers Fork, east of the town of Elkins. Northeast of Parsons, this range attains an elevation of 3800 feet, gradually reaching 4700 feet at the head of the Shavers Fork. Knobs on Shavers Mountain, which parallels Shavers Fork immediately to the southeast, reach elevations of 4800 feet. The whole region east of the Chestnut Ridge, of the Tygart River above Grafton, and of the Buckhannon River, is mountainous.

DRAINAGE.

It is obvious that the rock formation, together with glacial action, has had a great deal to do with the drainage system of the basins. To some extent the two main rivers

have followed the softer materials and probably have been influenced, more or less, by the general dip of the formations.

By inspection of the map it will be seen that both of the main streams, for much of their length, follow a course close to the western watershed. At Parker, for instance, there is an intervening distance of only 6 miles; and in fact, from Franklin to Pittsburgh, the distance between the main river and the western watershed would not average much more than this. Along this narrow stretch, in which the stream has a length of about 126 miles, only two tributaries of any importance are received by the Allegheny. About 59 per cent of the basin area lies to the east of the Allegheny and Monongahela Rivers, the Tygart Valley River being considered as a part of the main stream of the latter.

The tributaries of both rivers average larger on the east, are more numerous, have greater slopes, and for the most part flow in narrower and more rugged valleys, frequently on solid rock beds. In portions of these tributaries, notably in the Clarion, Kiskiminetas, Youghiogheny, Cheat and Tygart valleys, unusually huge rocks, some of them of conglomerate formation, have fallen down on the slopes and into the stream bed. With the exception of the lower reaches of the Kiskiminetas and Youghiogheny, nearly all the eastern valleys are comparatively thinly settled and are but little developed, whatever cultivation there is being mostly on the upland. On the west, the larger valleys are more open, and cultivated to greater extent. In the glacial region portions, some of the larger streams meander sluggishly through long reaches of nearly level bed, which, in a number of cases, are extensive swamps lying over buried valleys.

The principal Allegheny tributaries on the east, 13 in number, have an average length of 47 miles and an average fall per mile of 22.8 feet. The principal tributaries on the west, 10 in number, have an average length of 37 miles and a fall per mile of 16.7 feet. The Monongahela, on the east, has 9 tributaries, with an average length of 45.6 miles and fall per mile of 31.9 feet; on the west, 7 tributaries, with an average length of 44 miles and fall per mile of 19.7 feet.

The streams with a drainage area of 50 square miles or over, directly or indirectly tributary to the two rivers, are 67 in number, and have a total drainage area of 15,907 square miles, or 84 per cent of the combined area of the two basins. Of this area, 59 per cent is in the Allegheny Basin, and 41 per cent in the Monongahela.

It is considered by geologists that a remarkable diversion of drainage has taken place, involving the Allegheny and a large part of the Ohio, together with many of the lateral streams. From the study made of the whole region, it is thought that three principal buried channels of ancient origin have been discovered. The upper one, leading northwardly from the vicinity where Salamanca now stands, originally caused all the Allegheny above that place to enter Lake Erie a few miles northeast of Dunkirk, New York, while that part of the Allegheny now flowing southwardly to Warren, moved in the opposite direction, joining as a tributary near Salamanca.

The middle buried channel has a northwesterly course from the mouth of French Creek, and would indicate that the Allegheny originally flowed northwestwardly along the line of French Creek, passing Conneaut Lake and entering Lake Erie in Pennsylvania, near the Ohio state line. In this case the present Allegheny, from a point south of Warren, served as the main stream, but the part nearly as far down as the mouth of the Clarion flowed northwardly as a tributary.

It is thought that from the mouth of the Clarion River southward no material change has taken place, and that the Clarion formed a part of the main stream, with all tributaries much the same as now. The Ohio flows over its original bed as far as the mouth of the

Beaver, from which point it is supposed to have turned north along the line of the Beaver, then along Mahoning River, in the state of Ohio, joining Lake Erie via the Grand River. A considerable reach of the Ohio, below the mouth of the Beaver, flowed northeastwardly along the present channel, as a tributary. No change is believed to have occurred in the general course of the Monongahela.

GEOLOGY.

Within the watershed of the Allegheny and Monongahela Basins, the geological formation is one of national importance, especially when considering the resources of coal, oil and gas. Although large amounts of the mineral wealth have been expended, by far the greater part remains to be taken from the ground. The greater part of the combined area is mineralized, the minerals found including coal, oil, natural gas, building stone, shales, limestone, plastic and flint clays, sand, gravel and iron ore.

Coal.

About 13,000 square miles, or 70 per cent, are laid with coal, of which 2100 square miles, or 11 per cent, is the well-known Pittsburgh coal bed, averaging about 7 feet in thickness and containing, in its original state, probably 16.4 billion tons of commercial coal.

The whole stratified rock structure of the Allegheny valley has a southerly dip, sufficient to cause the strata to be thrown out to the surface. For a distance of about 255 miles below the headwaters, the bed of the Allegheny River lies in a series of formations composed of shales, sandstones and conglomerates, each in turn being cut by the stream, until a geological distance or thickness of about 3000 feet has been traversed. Several small beds of coal are held in the top of the conglomerate. Next in order along the river, and overlying the above strata, are the measures containing workable coal beds, also interlaid with sandstones and shales, all of which keep dipping down under the river, in a southerly or southwesterly direction.

The bottom of the above coal measures is reached in the vicinity of Red Bank Creek, and from here to the mouth of the river, a distance of about 65 miles, about 550 feet of the strata have been cut by the river. The lower formation of these measures has a thickness of about 300 feet, and its highest coal bed, the Upper Freeport, lies about 250 feet under the water surface at Pittsburgh. Although the bottom of the measures, as above stated, is reached by the river near the mouth of Red Bank Creek, the incline of the strata, in passing through the high country away from the valleys, permits the field to extend much further to the north.

Around the head of the Ohio, the Pittsburgh bed outcrops in the hills about 350 feet above water, and from here up the Monongahela it keeps above water, in a series of waves caused by anticlines and synclines, for a distance of nearly 50 miles, when it descends under water, reappears at 60 miles, again descends at 65 miles and reappears at 81 miles, ascending into the hills. From this point southwardly, the greater part of the immediate valley of the Monongahela River is barren of coal, which is present, however, in the hills above the stream. To the west or southwest, the coal dips deep under the tributaries. The part of the basin area which holds the Pittsburgh coal bed is in the southwest, and in a general way would be bounded by a line drawn from Pittsburgh to Black Lick, Pa., thence to Weston, W. Va. This coal originally was of vast area, eastwardly and northwardly, but the wearing down of the country has greatly reduced it. With the exception of several comparatively small areas, no coal exists in the

higher southeastern portion of the basin area, and none is present on the greater part of the Chestnut Ridge, or on much of the Laurel Ridge, in Pennsylvania. There is little coal to be found in the immediate valley of the West Fork above Clarksburg. The production of coal is considerably greater in the Monongahela than in the Allegheny Basin.

In some of the coal-bearing valleys where there are two or more workable beds, these are frequently widely separated, with the stream lying in the intervening space, which may be taken up by shales or sandstones. In many cases where the horizon of the coal is high, the streams have cut down entirely below the measures, causing them to crop out back on the hillsides, in some places at great height. In a considerable portion of the coal area in the lower half of the combined basins, there are 7 or more beds of commercial value, varying in thickness from 3 to 11 feet. For an average distance of about 30 miles below the entire northern end of the basins, no coal is found, this area being taken up with shales and sandstones.

Oil and Gas.

The oil and gas belt, as developed to this time, passes through the combined basins from the northeast edge, paralleling, in a general way, the mountain ranges which lie to the east. The course of the belt is about S. 35° W., and the axis, where it enters the basin, is about 16 miles east of Olean. From here to the vicinity of Franklin, most of the belt lies south of the Allegheny River, with the axis nearly 10 miles to the southeast of that city. Pittsburgh is nearly on the axis, and here the field has a total width of over 30 miles. In continuing southwardly, it is found that the eastern edge of the belt is practically bounded by the Monongahela River as far as Fairmont, West Virginia; and that further to the south, to the southwestern edge of the basin, the field involves the greater part of the West Fork River drainage area.

The oil and gas industry rapidly moved to the southern half of the basins, and it is notable that probably the largest producing gas field, when considering the area, has recently been opened on the upper reaches of the West Fork River. This field is now being heavily drawn upon. The productive field is not of solid formation, but is separated into hundreds of areas or pools, regardless of the land surface, some small and others covering considerable extent of country.

The commercial discovery of oil and gas occurred in the northern part of the Allegheny Basin, in the year 1859, and while the general utilization of the product progressed considerably from that time, it was not until about 20 years later that the tremendous activity began, which has ever since continued. The Allegheny River region has been the pioneer of the oil and gas business. Science or experience has determined no definite way of estimating the life of these resources, but it is evident that much of the area will soon be entirely depleted, as parts of the older sections have been reduced from an output of many hundreds of barrels per well per day to about two or three barrels, and many wells have been abandoned.

Glaciated Area.

Slightly to the north, and generally paralleling the limit of the coal field, is the Terminal Moraine, north of which is the glaciated field, covering about 2900 square miles, or 25 per cent of the area of the Allegheny Basin. The southern limit of the glacial field, as marked by the moraine, involves only a small reach of the Allegheny River, at Olean, the remaining part of the moraine being situated a few miles to the north of the

stream, which it follows in a general way, crossing Great Valley Creek 4 miles north of Salamanca, Conewango Creek 8 miles north of Warren, and, keeping to the north of Titusville, crosses French Creek 6 miles above the Allegheny River at Franklin.

The glaciers, which had a thickness of many hundreds of feet, passed across the country, wearing it down and breaking off fragments of rocks, which were finally worn into rounded stones or pebbles, and, through disintegration, to a considerable extent formed into sand. This material gradually descended to the bottom of the ice-sheet and was deposited, in many places to great depth. In fact it has been found to extend to a depth of 300 feet, or more, in some of the valleys and upland country of the Allegheny Basin, to which locality the glacier moved in a southerly direction, as indicated by the striae upon the surface of the solid rock and the general conformation of the worn parts. Investigations made by geologists have shown that a large part of the material carried was received from the granites and other hard rocks of the far north, and for this reason, the sand, especially as found in the Allegheny River and some of its tributaries, is hard, sharp and clean.

Along the southern edge of the ice sheet, where it melted, a moraine was formed, made up of an accumulation of a certain amount of earthy material, but largely composed of sand, pebbles, boulders and irregularly shaped fragments of stone, some of the last mentioned being planed off on only one or two sides and frequently striated. The gravel, which forms the greater part of the bed of the Allegheny, traveled down the natural trough of the valley from the glacial field, and in few cases, judging from limited observations made at the time of the stream examinations, found its way, in any considerable amount, into the tributaries, with the exception of those flowing in a southerly course directly from the field.

The region north of the moraine abounds in small glacial lakes and swamps, the former to the number of about 15, all tributary to the Allegheny. The largest of the lakes is Lake Chautauqua, situated in the southwestern corner of New York State, with an elevation of 1308 feet, a length of 18 miles and an average width of 1.2 miles. The next largest is Conneaut, located very near the western edge of the basin, in Crawford County, Pa., with an elevation of 1072 feet and a length of 2.6 miles.

FOREST COVER.

In the original conditions, before the great activity of man, practically all the drainage area above Pittsburgh was heavily timbered. Probably as much as 18,000 square miles were wooded with a growth of commercial value. Through the cooperation of the United States Forest Service and the Pennsylvania Forestry Department, a field investigation of the present conditions and area of forest cover on the drainage basins has been made. The report on this investigation is given in Appendix No. 1, together with a map, showing the extent and distribution of the wooded areas.* Computing the total area of virgin forest, as shown on this map, it is found that only about 360 square miles, or 2 per cent, remain, scattered in numerous detached parts, over the high land of the northeastern and southeastern portions of the basins. It is true, of course, that in the aggregate a large area has been permitted to regrow, in many places two and three times over, and these areas, at present, total about 7700 square miles, or 41 per cent of the combined basin area. A part of this, however, is evidently composed of comparatively small timber. About 42 per cent of the Allegheny Basin is wooded and about 39 per cent of the Monongahela. The total area destroyed by fire in the two basins exceeds 400 square miles, or over 5 per cent of the

*This map will be found in the pocket at the back of the book.

wooded area, and a large part of this has involved virgin timber. The burned area has been estimated from present indications only.

Nearly all the more thickly wooded country in the Allegheny Basin lies in Potter, McKean, Warren, Forest, Venango and Elk counties, Pa., and southern Cattaraugus County, N. Y., generally at altitudes of between 1500 and 2000 feet. The extreme southeastern corner of the Allegheny Basin is fairly well timbered in Cambria, Westmoreland and Somerset counties, principally on the Chestnut, Laurel and Allegheny ridges, above elevations of 1500, with the larger part occurring above 2000 feet. As may be noted on the forest map, these mountains, as well as Negro Mountain, can readily be traced by the forest cover, which condition continues on the high elevations into the upper regions of the Monongahela. By far the greater amount of timber in the basins lies on an altitude above 1500 feet. Over about all of the western half of the two basins the wood cover is broken up into innumerable small areas, sometimes widely separated. This condition obtains across the entire narrow part of the Allegheny Basin in Jefferson, Indiana and Armstrong counties.

The prevailing forest types and the regions where largely found are as follows: White pine, in the north and northeastern part of the Allegheny; spruce, in the southern portions of the Monongahela; hemlock, mixed oaks and chestnuts, scattered over the two basins; beech, birch, maple and basswood, also scattered over both basins, but commonly above 2000 feet, and, on the Allegheny, mostly around the headwaters.

The following table shows the drainage and wooded areas of the various tributaries of the Allegheny and Monongahela Rivers. The drainage areas were measured on the Flood Commission's original map of the basins, carefully prepared from the best available data on a scale of 1 inch equals 4 miles; the wooded areas, on the original map of the U. S. Forest Service, scale, 1 inch equals 6 miles.

TABLE No. 3.

DRAINAGE AND WOODED AREAS OF ALLEGHENY AND MONONGAHELA RIVERS AND TRIBUTARIES.

ALLEGHENY BASIN

Stream	Total area (Sq. mi.)	Wooded area (Sq. mi.)	Wooded (Per cent)	Cleared (Per cent)
Allegheny	11580	4863	42	58
Buffalo	167	56	34	66
Kiskiminetas	1877	693	37	63
Beaver	55	9	16	84
Loyalhanna	278	87	31	69
Black Lick	414	165	39	61
Conemaugh above Stony Creek	188	103	55	45
South Fork	61	32	52	48
Stony	464	205	44	56
Shade	95	72	75	25
Quemahoning	109	45	43	57
Crooked	287	68	24	76
Cowanshannock	63	15	24	76
Big Pine	52	13	25	75
Mahoning	417	128	31	69
Red Bank	585	222	38	62
Little Sandy	79	30	38	62
North Branch	102	67	66	34
Bear	61	20	33	67
Clarion	1213	762	63	37
Sandy	152	55	36	64
East Sandy	104	66	64	36

TABLE No. 3—(Continued.)

DRAINAGE AND WOODED AREAS OF ALLEGHENY AND MONONGAHELA RIVERS AND TRIBUTARIES.

ALLEGHENY BASIN

Stream	Total area (Sq. mi.)	Wooded area (Sq. mi.)	Wooded (Per cent)	Cleared (Per cent)
French	1238	243	20	80
Sugar	163	40	25	75
Conneaut Lake	95	20	21	79
Cussewago	105	17	16	84
Woodcock	67	7	10	90
Muddy	75	15	20	80
East Branch	86	17	20	80
North Branch	217	51	23	77
Oil	303	128	42	58
Tionesta	477	411	86	14
Hickory	56	54	98	2
Brokenstraw	319	148	46	54
Little Brokenstraw	79	34	43	57
Conewango	892	215	24	76
Kinzua	169	154	91	9
Great Valley	137	44	32	68
Tuneungwant	160	125	78	22
Olean	201	51	25	75
Oswayo	246	159	65	35
Potato	225	169	75	25
Allegheny above Potato	300	200	67	33

MONONGAHELA BASIN

Stream	Total area (Sq. mi.)	Wooded area (Sq. mi.)	Wooded (Per cent)	Cleared (Per cent)
Monongahela	7340	2857	39	61
Turtle	145	16	11	89
Youghiogheny	1732	851	49	51
Big Sewickley*	158	14	9	91
Jacobs	101	26	26	74
Indian	126	84	67	33
Laurel Hill	128	83	65	35
Casselman	448	254	57	43
Youghiogheny above Confluence	432	250	58	42
Redstone	109	15	14	86
Ten Mile	334	61	18	82
Whiteley	52	9	18	82
George	66	14	21	79
Dunkard	229	41	18	82
Cheat	1410	973	69	31
Big Sandy	201	105	52	48
Dry Fork	502	390	77	23
Shavers Fork	211	176	83	17
Deckers	62	29	47	53
Buffalo	122	19	16	84
Tygart Valley	1369	587	43	57
Three Fork	103	40	39	61
Sandy	87	28	32	68
Teters	53	19	36	64
Buckhannon	304	114	37	63
Middle Fork	152	89	58	42
West Fork	876	129	15	85
Ten Mile	126	27	21	79
Elk	120	10	8	92

*Also called Sewickley.

PRECIPITATION.

By careful research the Flood Commission has obtained records of 84 rainfall stations scattered over the Allegheny and Monongahela Basins, all of which are operated under the supervision of the United States Weather Bureau. About 50 of these stations have been in operation for a period of over 20 years, while the Pittsburgh station has been in service for 68 years.

A study of these records shows that the mean annual precipitation over the Allegheny Basin amounts to 42.4 inches. The lowest mean annual rainfall, 37 to 39 inches, prevails close along the Lake Erie front and from here increases southwardly. The Clarion and Kiskiminetas River Basins probably receive more rainfall than those of any other tributaries on the Allegheny Basin. The Clarion has a mean annual rainfall of about 43 inches at the mouth, increasing to 46.4 inches at Clarion and then falling to about 38 inches at its source. The Kiskiminetas has a rainfall of 42.2 inches at its mouth, decreasing to 38.7 inches at Saltsburg, and then increasing to 45.1 inches at Johnstown and reaching a maximum of 48 inches at its source. The minimum annual rainfall recorded on the Allegheny Basin occurred in 1887, at Saltsburg, Pa., when the total precipitation for the year was only 22.3 inches. The maximum annual rainfall occurred in 1870, at Franklin, Pa., when the total precipitation for the year was 59.7 inches.

The mean annual rainfall on the Monongahela Basin is 45.5 inches. The region of lowest rainfall is along the lower reaches of the valley, the minimum mean annual precipitation, 39.2 inches, being at Lock No. 4. The greatest mean annual rainfall occurs along the Allegheny Mountain ridges in West Virginia, the average at Pickens being 55.5 inches, and at Terra Alta 57.9 inches. The basins of the Youghiogheny and Cheat Rivers receive a greater precipitation than those of any other tributaries. In years of heavy rainfall the annual precipitation is considerably greater than the above figures, the maximum recorded at Pickens being 80.9 inches, in 1907, and at Terra Alta, 75.5 inches, also in 1907. The minimum annual rainfall on the two basins is recorded for 1886, at Rowlesburg, and amounted to only 19.1 inches. It is interesting to note the wide range in the annual rainfall at this station, where the variation is the greatest of any of the stations studied, the maximum of 72.1 inches, in 1907, being nearly four times the above minimum.

It is notable that in 60 different cases the monthly rainfall has exceeded 10 inches at various stations, while several times it has exceeded 15 inches. Records show that in general July is the month of maximum rainfall.

Reliable records of snowfall on the combined basins are decidedly meagre. The Flood Commission has succeeded in getting together authentic data on this subject for the winter of 1909-10. A comparison of the map showing lines of equal mean annual rainfall, Plate 91, Appendix No. 2, with the map showing distribution of snowfall for the above mentioned winter, Plate 1, Chapter III, shows a very marked resemblance. The summits of high rainfall, Clarion, Pa., Humphrey, N. Y., Somerset, Pa., Terra Alta, W. Va., and Pickens, W. Va., are also summits of high snowfall. The total depth of fallen snow on the Allegheny Basin varied from 47 inches at Pittsburgh to 112 inches at Clarion, Pa., and from 29 inches at Morgantown to 117 inches at Pickens, W. Va., on the Monongahela Basin.

Although in general the total snowfall on the Allegheny and Monongahela Basins is nearly the same, there is a great difference in the length of time snow stays on the ground on the two basins. Over the whole Allegheny Basin, as far south as the

mouth of the Kiskiminetas River, in the winter of 1909-10, a blanket of snow from 2 to 5 feet in depth was the general condition. On the northern part of the basin, in a belt from a point a little north of Corry, Pa., southeast to Brookville, Pa., the snow lay to a depth of about 4 feet for over a month. South from the mouth of the Kiskiminetas to below Pittsburgh, the depth across the basin was considerably less. In fact a depth of 8 to 12 inches is about as great as is generally found for any considerable length of time on the Monongahela Basin, even on the high lands, south of the Pennsylvania state line. In this part of the basin, on the lower levels, and under about 1500 feet, the ground is frequently bare for much of the winter.

DISCHARGE.

The greatest discharge of the Allegheny at Pittsburgh occurred in February, 1891, and is estimated to have reached about 300,000 second-feet, or 26 second-feet per square mile of drainage area. The minimum discharge at the mouth is about 950 second-feet, or 0.082 second-foot per square mile.

The maximum discharge at Kittanning, 46 miles above the mouth, which occurred in 1865, is estimated to have amounted to 245,000 second-feet, or 27.2 second-feet per square mile. This is the maximum flood recorded for the Allegheny, except in the 30 miles below the mouth of the Kiskiminetas, where the maximum, as above stated, occurred in 1891. The height of the crest of the 1865 flood above low water at various points along the Allegheny, above Freeport, as taken from the profile of the U. S. Engineers, survey of 1897, was as follows:

Oil City	22 feet	Parker	25 feet
Franklin	23 "	Red Bank	24 "
Kennerdell	26 "	Mahoning	28 "
Emlenton	31 "	Kittanning	30 "
Foxburg	25 "	Ford City	32 "

The maximum discharge at Lock No. 4, on the Monongahela, 41 miles above the mouth, from a drainage area of 5430 square miles, occurred in 1888, and amounted to 207,000 second-feet, or 38.1 second-feet per square mile. It is notable that this maximum discharge, as well as that on all important tributaries of the Monongahela above this point, occurred in July, usually a low-water month. On account of the navigation dams, no systematic record of low-water flow of the Monongahela has ever been made, but the estimated discharge at the mouth in 1908 was 325 second-feet, or 0.044 second-foot per square mile. The reports of the Chief of Engineers, U. S. Army, give the minimum discharge as 160 second-feet, or 0.022 second-foot per square mile.

TEMPERATURE.

Except at a few points, authentic records of temperature extending over any considerable period are not available for the Allegheny and Monongahela Basins. In all, records of 26 stations within the basin have been collected. These records tend to show that the mean annual temperature of the Allegheny Basin is from 2 to 3 degrees lower than that of the Monongahela. There seems to be little or no relation between the temperature and elevation on either basin.

TABLE No. 4.

TEMPERATURE AT UNITED STATES WEATHER BUREAU STATIONS.

(In or near the Allegheny Basin.)

Station	Maximum	Minimum	Mean	Elevation
Pittsburgh	103	—20	52.7	704
Freeport	97	—16	....	772
Johnstown	102	—17	51.4	1184
Indiana	97	—22	49.9	1350
Clearfield	98	— 8	....	....
Skidmore	96	—16	....	910
Grove City	94	—19	....	1250
St. Marys	95	—14	....	1749
Franklin	100	—30	48.6	955
Greenville	97	—24	48.2	950
Saegerstown	99	—35	47.1	1116
Warren	98	—26	47.1	1206
Jamestown	95	—31	47.2	....
Erie	94	—16	48.8	714
Franklinville	95	—34	44.6	....
(In or near the Monongahela Basin.)				
Pittsburgh	103	—20	52.7	704
Irwin	99	—12	....	884
Cassandra	98	—19	47.8	2000
Derry	103	—21	51.2	2300
Lycippus	100	—22	51.1	1420
Claysville	98	—16	....	1030
California	99	—12	....	770
Somerset	98	—24	47.5	2250
Uniontown	98	—22	52.5	1000
Aleppo	97	—17	50.9	1060
Morgantown	105	—25	52.8	1250
Terra Alta	94	—24	48.8	3207
Grafton	99	—27	52.3	985
Lost Creek	99	—35	52.1	1033
Philippi	100	—28	52.1	1192
Parsons	95	—21	50.2	1662
Buckhannon	99	—31	51.7	1472
Glenville	100	—29	53.3	....
Elkins	94	—21	49.8	1940
Pickens	96	—24	49.9	2785

DEVELOPMENTS.

History indicates that the first white man navigating the Allegheny River, or the Ohio River, as it was known for many years after discovery, was a Frenchman, who, in company with some Indians, descended the stream about 240 years ago, coming by various portages from the St. Lawrence. Nearly a century later, or about the year 1749, another Frenchman descended the stream, also in company with Indians. Then followed the founding of Pittsburgh, in the year 1758. At about this time, bituminous coal, the first coal found in Pennsylvania, was discovered, and in 1792 the first blast furnace in Pittsburgh was built.

Water Transportation.

In the early development of Pittsburgh, the transportation afforded by the natural waterways was of great importance. The first steamboat on western rivers, called the

New Orleans, was built at Pittsburgh, in 1811. From this time on, navigation rapidly increased and developments in general broadened along the Allegheny, Monongahela and Ohio Rivers.

Rivers. The Monongahela River is slackwatered by means of 15 locks and dams, from the mouth to a point on the West Fork River, 4 miles above Fairmont, W. Va., a total distance of 131 miles. The lower 89.5 miles of this stretch of the river was canalized by the Monongahela Navigation Company, incorporated under an act of the legislature of Pennsylvania in 1836. This company constructed seven locks and dams, providing slackwater from Pittsburgh to within 2 miles of the West Virginia state line. These works were acquired by the U. S. Government in 1897. The other locks and dams in the system were built by the Government and were completed as follows: No. 9, 1879; No. 8, 1889; Nos. 10 to 15, inclusive, 1904. The first lock and dam of the system is 1.9 miles above the head of the Ohio.

The depth over lock sills at dams Nos. 1 to 5, inclusive, is 8.5 feet; at No. 6 is 6.7 feet; at No. 7 is 6.0 feet; at No. 8 is 5.0 feet; at No. 9 is 5.3 feet; at Nos. 10 to 15, inclusive, is 7.1 feet. Dams Nos. 1, 2, 3 and 5 have two locks, 56 feet by 360 feet; No. 4 has two locks, 50 feet by 158 feet and 56 feet by 227 feet, respectively; Nos. 6 to 9, inclusive, have single locks 50 feet wide and from 159 to 165.5 feet long; Nos. 10 to 15, inclusive, have single locks 56 feet by 182 feet. The lifts of the locks at low water vary from 4.4 feet to 13.0 feet.

The Youghiogheny River was slackwatered, by private interests, about the year 1850. This was done by two locks and dams, the improvement extending from the mouth to West Newton, a distance of 19 miles. The structures, being largely of wood, were several times severely damaged by high water and ice, and the works were abandoned about the year 1868. The government has recently made surveys and is now making plans for reestablishing slackwater to West Newton, with a navigable depth of 8.5 feet. In 1875, surveys were made across the divide from the Potomac River to the mouth of the Youghiogheny, for the purpose of a connecting waterway between the Chesapeake and Ohio Canal and the Ohio River.

The Allegheny River has been improved by the United States Government with a system of three locks and dams, which extend slackwater, with a navigable depth of 8 feet, from the mouth of the river to Natrona, a distance of 24 miles. Lock No. 1 is 55 feet by 286 feet, and Nos. 2 and 3 are 56 feet by 289.5 feet. The lifts at low water are 7, 11 and 10.5 feet, respectively. This improvement was made between 1893 and 1908. Above Natrona, at the foot of Jacks Island, the river remains in its natural state, with the exception of a few short reaches where the government has built small works, such as dykes, designed for improving the depth at shoals.

Surveys of certain reaches of the stream, by the U. S. Engineers, have been made as follows: 1828, Franklin to Pittsburgh; 1878, Olean to Franklin; 1897, Oil City to Tarentum. The large scale maps of the latest survey show the physical characteristics of the whole stream bed in detail. At the time of the survey of 1897, estimates were made for the extension of slackwater to Oil City, 112 miles above Tarentum, and also from that place to the New York state line. It was found that the total lift of 280 feet, to Oil City, required 22 locks, including the 3 now built. From Oil City to the state line, a distance of 77 miles, 35 locks were required, or a total of 57 locks from Pittsburgh to the state line. The lifts ranged from 8 to 15 feet, and the proposed dimensions of the locks were as follows: Length 290 feet, width 56 feet and depth 8 feet. In connection with this project a brief report was made, bearing upon the feasibility of a canal between the Allegheny River at Franklin and Lake Erie.

The Allegheny has been navigated by steamboat as far as Olean, 254 miles above the mouth, but traffic by steamboat on the river above Kittanning, 45 miles above the mouth, has never been active, and at present, exists for only a short distance above Pittsburgh. Navigation cannot be accomplished at the usual low summer stage, at which time the depth over the shoals is frequently only about 5 inches, while the small steamers require at least 2 feet.

Many million feet of lumber have been floated, by the current, from the upper part of the main stream and from many of the tributaries, especially the Tionesta, Clarion and Mahoning. The movement of lumber in this way has been steadily decreasing, however, and it is said that even on these streams it is nearly a thing of the past. In the last ten years the floating of timber and boats on the Allegheny has decreased nearly 50 per cent.

Practically the entire business on the river, including some of the principal tributaries, has been the floating of timber and various kinds of boats, built largely for the Ohio traffic, and to some extent, for use in the rivers about Pittsburgh. Floating is usually not attempted on a stage less than 18 inches, over the riffles, and is usually done on the favorable spring and fall stages. The best running is done on a stage of about 4 feet, above Franklin, increasing gradually to 10 feet at Pittsburgh. Under this condition it is possible, with properly loaded coal boat bottoms and little or no head winds, to reach Pittsburgh from Tionesta in 33 hours, running time. The dimensions of the floating craft and the amount of water they draw, are as follows:

	Dimensions	Draft
Boat bottoms	26 feet x 170 feet	5 inches, light
Barges, pine	26 " x 135 "	12 " "
Barges, hemlock	26 " x 135 "	15 " "
Flats	16, 18, 20 " x 90 "	16 " "
Rafts, boards	52 " x 360 "	3.5 to 4 feet
Rafts, timber	60 " x 375 "	1.5 " 2.5 "

Davis Island dam, 4.7 miles below the head of the Ohio, or the "Point" at Pittsburgh, was completed in the year 1885. This very important dam forms the harbor of Pittsburgh, and backs water into the Allegheny and Monongahela Rivers, reaching the lower lock of each with a least navigable depth of about 9 feet.

There are, at present, a total of 155 miles of slackwater improvement on the two rivers above Pittsburgh, directly connected with the city. Below, in the upper Ohio, 30 miles of canalization have been completed by means of six locks and dams, and this slackwater system is being extended toward the mouth. The locks are all 110 feet by 600 feet, and have a depth over miter sill of from 9 to 11 feet. The lifts vary from 3.1 to 8.5 feet.

The total harbor tonnage in 1910, including the rivers above the city, was 12,314,-664 tons, while the Ohio tonnage amounted to 3,140,533 tons.

Canals. The importance of water transportation to this new western country naturally led to an early consideration of plans for the connection of the various natural waterways. It was not until the year 1834, however, that the first project entering this district was completed and opened to navigation, namely, the Pennsylvania Canal, which was built across the State of Pennsylvania, to connect tidewater with the Ohio River at Pittsburgh, and in this way not only to secure communication with this district, but with the far west. This canal entered the Allegheny Basin over a summit of 2340 feet, about 31 miles northeast of Johnstown, and for conveying the traffic across the Alleghenies, had a link composed of inclined planes. From Johnstown, the canal proper, of

4 feet depth, continued to Pittsburgh via the Conemaugh, Kiskiminetas and Allegheny valleys. This western division of the canal was abandoned in the year 1864.

In the year 1834, a canal of 4 feet depth was opened for business, between the mouth of French Creek and a feeder branch of the main line of the Pittsburgh and Erie Canal, connection being made south of Meadville. About 1857, a canal of 4 feet depth was opened to navigation between the Genesee River and the Allegheny River; the route into the Allegheny Basin, over a summit of about 1485 feet, being via Olean Creek to a junction with the Allegheny at the town of Olean. This canal was abandoned in 1878.

An important project, which has been under consideration for a number of years, is the building of a canal between the head of the Ohio and Lake Erie. Under the auspices of a State Commission, the first surveys were made in 1890 from Davis Island dam to the harbor of Conneaut, situated on Lake Erie, 25 miles west of the Pennsylvania state line. The route was via the Ohio and Beaver Rivers, keeping mainly in the State of Pennsylvania. In 1895, under the auspices of the Chamber of Commerce of Pittsburgh, a survey was made for a canal via the Ohio, Beaver and Mahoning Rivers, with the route of the canal proper over the summit lying between Niles, Ohio, and Ashtabula, on Lake Erie. In 1905, a company was incorporated under charters obtained from the States of Pennsylvania and Ohio, and a survey made over the same route as the one of 1895, except that near the northern end the route turned slightly to the west and joined Lake Erie about 7 miles west of Ashtabula. This company also obtained a National charter by act of Congress in 1906. Recently, enabling legislation has been passed in the States of Pennsylvania, Ohio and West Virginia, permitting counties to contribute money for such a waterway.

Railroads.

In the valley of the Allegheny, the Buffalo and Allegheny Valley Division of the Pennsylvania Railroad extends close along the left bank of the river from Pittsburgh to Oil City, from which place it follows the right bank to Warren and then continues, alternating between banks, nearly to the head of the stream. On the right bank, the Conemaugh Division of the Pennsylvania Railroad extends from Pittsburgh to Freeport, and then crossing to the left bank, ascends the Kiskiminetas River. Five other railroads touch the stream for comparatively short distances at scattered points.

Railroads extend along practically the entire length of the Monongahela and Tygart Valley Rivers. On the Monongahela, the only part now remaining upon which there is not a railroad, is a stretch of about 7 miles, immediately below the mouth of Cheat River. Below this stretch the Pennsylvania and P. &. L. E. railroads border the greater part of the river. The B. & O. Railroad and lines of the U. S. Steel Corporation occupy much of the banks below the mouth of the Youghiogheny. The former road also occupies the valley of the Youghiogheny and a considerable portion of the Monongahela Valley above the Cheat River.

The following will serve to show the progress of railroad development in the combined basins and its extent at various dates. In 1860, the total mileage in the Allegheny Basin was 400 miles, and in the Monongahela, 240 miles, or a total of 640 miles for the two basins. In 1880, the mileage had increased, in the Allegheny, to about 915 miles, and in the Monongahela, to 360 miles, or a total of 1275 miles. After 1880, railroad building rapidly increased, and it has been found that in 1910 the Allegheny Basin had 2740 miles, and the Monongahela 1600 miles, or a total of 4340 miles, which

is equal to the mileage of the whole State of Virginia, and about double that of New Jersey.

The only portions of the Allegheny proper having a railroad in 1860 were as follows: Pittsburgh to Kittanning, 46 miles; mouth of Brokenstraw Creek to Warren, 8 miles; and Red House to Olean, 28 miles, the latter stretch being near the headwaters, in New York State. The only tributaries of the Allegheny having railroads at that time were French Creek, Brokenstraw Creek, the upper part of the Conemaugh, and a portion of Black Lick Creek. So far as can be determined from records, the only railroad along the Monongahela River extended from Pittsburgh to the mouth of the Youghiogheny, and along tributaries, from the mouth of the Youghiogheny to Connellsville and along the lower portion of Turtle Creek.

As late as 1880, only 13 of the 67 principal tributaries of the combined basins had railroads to any material extent. It is notable that, in the year 1911, 6 of the principal tributaries remain without a railroad, and 9 others are not involved for distances varying from 7 to 36 miles, largely the lower reaches, or parts favorable for reservoir treatment.

Industrial Developments.

The industrial developments on the Monongahela are comparatively all on the reach within about 55 miles of the mouth, and the greater part of this distance is taken up by steel and other manufacturing concerns. The thickly covered manufacturing district extends about 15 miles above the mouth. The coal mining interests are also in this part of the stream and at many points above. On the Allegheny, the important industries are nearly all located within 45 miles of the mouth, and the thickly covered portion extends along the lower 6 miles. Steel plants of large output are scattered along the Ohio River for a distance of 25 miles below the city.

Population.

The total population of the Allegheny Basin is 1,200,000, of the Monongahela, 1,160,000, and of the combined basins, 2,360,000, which is slightly greater than that of the State of Kentucky.

ALLEGHENY RIVER.

GENERAL COURSE AND SLOPE.

The Allegheny River rises in Potter County, Pennsylvania, and after flowing 53 miles in a northwesterly course, enters the State of New York, through which it flows 50 miles, turning back into Pennsylvania and taking a southwesterly direction 85 miles to the mouth of French Creek, at the City of Franklin. From here it flows southeastwardly 68 miles to the mouth of Mahoning Creek, and then, turning to the southwest, continues for a distance of 58 miles, reaching Pittsburgh after flowing a total distance of 314 miles.

About one mile below the source the stream has an elevation of 2210 feet above mean sea level, and from here the length and average fall per mile of five long reaches are as follows: To Colesburg, 5 miles, 76 feet; thence to Port Allegany, 23 miles, 16 feet; thence to Salamanca, 52 miles, 1.8 feet; thence to the mouth of the Kiskiminetas, at Freeport, 203 miles, 3.1 feet; thence to Pittsburgh, 30 miles, 1.1 feet. The elevation at the mouth is 703 feet. Beginning at Warren, 192 miles from the mouth, the length of certain long reaches and the average width between flow lines are given as

follows: Warren to Oil City, 58 miles, 780 feet; Oil City to Kiskiminetas River, 104 miles, 630 feet; Kiskiminetas River to Lock No. 2, 23 miles, 1270 feet; Lock No. 2 to mouth, 7 miles, 940 feet.

PHYSICAL FEATURES.

Valley. From the upper waters to the mouth, the river flows through a valley which for the most part is deep-set, steep-sided and narrow, although there are many areas of bottom land varying from small to comparatively large size. Some of the latter, particularly in the reaches above Brokenstraw Creek and below the Kiskiminetas River, follow the river-front for a distance of several miles or more and extend back to the steep hill slopes, in some cases a distance of over half a mile. At many places the lower parts of the steeper hillsides, frequently of rock formation, attain slopes of 35 degrees or more, and at some points are precipitous. The hills on each side of the valley have heights above river about as follows: Olean to Warren, 700 feet; Foxburg to Kittanning, 500 to 600 feet; Freeport to Pittsburgh, 350 to 400 feet.

The principal towns are located upon the larger of the flat areas, the greater number of which are partly or wholly occupied by developments of general character. South of Olean, N. Y., and above the Kiskiminetas River, most of the towns, with the exception of Warren, Oil City and Franklin, are located on the left bank. The general height of these flats above low water, for that part of the river which lies between Oil City and Pittsburgh, varies from 22 to 40 feet, while north of that place, the elevations are from 14 to 30 feet. In the aggregate, a considerable area of the flats is affected by floods.

The railroads at certain points are above low water as follows: Mouth of Kiskiminetas River, 32 feet; Kittanning, 41 feet; Red Bank Junction, 36 feet; mouth of Clarion River, 40 feet; Oil City, 30 feet; mouth of Brokenstraw Creek, 19 feet; Olean, 20 feet. In the city of Pittsburgh, the railroads on the flats bordering the rivers vary from 14 to 40 feet above low water.

Channel. As is the case with most streams, the river, above the improved part, which reaches 24 miles from the mouth, is made up of a series of riffles and natural pools, formed by deposits of sand and gravel across the stream bed. It is found by a study of the reach of river covered by the 1897 survey, that, at low stages, the pools range in length from about 0.5 of a mile to 2.7 miles, and have a greatest depth of from 15 to 22 feet. The riffles range in length from 0.1 of a mile to 1.3 miles, with a depth at low water frequently not exceeding 0.6 of a foot.

Some of the pools, at the low stage, have an almost inappreciable fall, while some of the riffles fall as much as 6 feet in a distance of 0.5 of a mile, one of them near Emlenton, falling 11.2 feet in 1.3 miles. At low stage the movement of the water in the pools is almost imperceptible. Between Olean and Tarentum there are 190 islands and bars, 262 riffles, and 263 pools. In this distance, 413 feet of the total fall is taken up by the riffles. A general inspection of the river shows that, while many of the soil-topped islands and most of the bars, both shore bars and those standing out in the water, are situated at or near mouths of tributaries, with evident reasons for their occurrence, some of them are found at intermediate places with no apparent cause for their formation. Geological conditions, together with other influences, have of course been responsible for the obstructions at these places, and also, to a greater or less extent, at the mouths of the tributaries.

The bed of the Allegheny River, at least below a 3 or 4-foot stage, including the

islands and along bank lines, is composed of a hard, packed mixture of sand and gravel, by far the greater part of which is coarse gravel, with a top layer of sand and clay, holding occasional particles of small gravel. The gravel, especially that of large size, is most abundant in the upper reaches of the river. Rock in place is seldom found along the shores, close to water, or on the water-covered bed. Some places have been found where bed rock is at surface or several feet below, on one side of the river, and out of reach of a 25-foot drill on the opposite side, the bed being filled over with gravel, so firmly packed that great difficulty has been experienced in driving into it a sharply-pointed ordinary steel drill. In places in the upper reaches, it has been found almost impossible to make drills penetrate 10 feet into this gravel formation.

The direction of the stream has evidently changed but little, conditions indicating that it has been flowing over the same bed for some centuries. This statement is somewhat verified when comparing the map of 80 years ago with the one of very recent survey, as below Oil City there is no perceptible change at many places along the river, either in the shore line or the islands.

A number of changes, however, have taken place since 1828, as may be readily observed by even a casual examination of the stream. Floods have entirely cut away the alluvial tops of several or more of the islands, leaving only a low gravel bar, and the banks along some of the valuable bottom land have been cut back, in a few places, for perhaps a hundred feet. Considerable of this cutting has probably occurred during the last 30 years. The islands have worn off, invariably across the upstream end, leaving exposed to view, at low stages, an area of gravel bar; while downstreamwardly, along the sides, the scour has increased laterally, until the lower ends have become quite sharp and but little shortened, so that the islands, in plan, are shaped much like a top.

The erosive effect of the small flood or ordinary low stage generally amounts to but little on this river, and this would also be the case with the present high stages under control and with a well-regulated flow assured; for it is the violent fluctuations of the very high stages that cause most of the erosion. Under such conditions, not only silt material, but also debris of various sorts, left upon the banks by previous floods, is carried away and deposited at points below.

The running of ice, frequently in large blocks, materially increases this action. High accumulations often occur along the banks for a distance of some miles, and especially where the blocks become frozen to the already weakened clay formation, it is natural to suppose that parts of the banks are pulled off when the ice mass breaks up. While gorges may generally occur on account of certain obstructions in the channel, it is also the case that they are much increased and made more dangerous by a second and higher flood closely following the first, causing the ice to pile up across the entire channel and for a long distance along the stream.

The tributaries transport but little eroded material, as the immediate slopes have hard and thin layers of soil, lying on a rock formation and frequently well protected by wood or brush cover.

The following table shows distance from Pittsburgh, by river channel, to towns and to mouths of important tributaries, together with elevations of these places, and distance and fall per mile between points.

TABLE No. 5.

DISTANCES, ELEVATIONS AND SLOPES ALONG ALLEGHENY RIVER.

Towns, mouths of tributaries and other points	Distance from mouth (Miles)	Elevation of water surface (Feet)	Distance between points (Miles)	Fall per mile between points (Feet)
Mouth of river	0	*703.0	...	...
Herr Island dam, Lock No. 1	1.7	*703.0 *710.0	1.7	...
Pine Creek	4.7	*710.0	3.0	...
Lock No. 2	7.0	*710.0 *721.0	2.3	...
Plum Creek	10.6	*721.0	3.6	...
Springdale, Lock No. 3	16.7	*721.0 *731.5	6.1	...
New Kensington	18.0	*731.5	1.3	...
Tarentum	21.8	*731.5	3.8	...
Natrona	24.0	*731.5	2.2	...
Buffalo Creek	28.6	736.0	4.6	0.7
Kiskiminetas River	30.2	737.0	1.6	0.6
Clinton	35.6	746.0	5.4	1.7
Crooked Creek	40.7	755.0	5.1	1.8
Ford City	42.5	760.0	1.8	2.8
Kittanning	45.6	766.0	3.1	1.9
Cowanshannock Creek	49.1	773.0	3.5	2.0
Pine Creek	51.2	777.0	2.1	1.8
Templeton	55.3	782.0	4.1	1.2
Mahoning Creek	58.2	786.0	2.9	1.4
Rimerton	60.9	791.0	2.7	1.9
Red Bank Creek	64.9	807.0	4.0	4.0
East Brady	70.5	812.0	5.6	0.9
Cat Fish Run	73.5	821.0	3.0	3.0
Black Fox Run	78.2	829.0	4.7	1.7
Monterey	80.7	832.0	2.5	1.2
Bear Creek	83.9	841.0	3.2	2.8
Parker	84.6	846.0	0.7	7.1
Clarion River	86.1	851.0	1.5	4.0
Foxburg	87.8	854.0	1.7	1.8
Emlenton	91.8	858.0	4.0	1.0
Dotter	94.8	871.0	3.0	1.0
Mill Creek	96.0	876.0	1.2	4.2
Wood Hill	98.2	885.0	2.2	4.1
Rockland	101.4	892.0	3.2	2.2
Little Scrub Grass Creek	102.6	896.0	1.2	3.3
Falling Spring Run	106.1	902.0	3.5	1.7
Big Scrub Grass Creek	109.4	915.0	3.3	4.2
Kennerdale	110.0	915.0	0.6	0.0
St. George's Run	114.8	923.0	4.8	1.7
Fosters	119.0	939.0	4.2	3.8
Astral	122.0	947.0	3.0	2.7
Two Mile Run	124.5	953.0	2.5	2.4
Franklin—French Creek	126.6	959.0	2.1	2.9
Prentice	128.7	968.0	2.1	4.3
Schaffers Run	130.4	973.0	1.7	2.9
Sedgwick	132.9	978.0	2.5	2.0
Oil City—Oil Creek	134.2	982.0	1.3	3.1
Alcohns Run	136.9	991.0	2.7	3.3
Horse Creek	137.9	992.0	1.0	1.0
Walnut Bend	141.1	1001.0	3.2	2.8
McMahons Run	142.4	1008.0	1.3	5.4
Pithole Creek	143.7	1013.0	1.3	3.9
Henry's Run	145.3	1015.0	1.6	1.9
Little Tionesta Creek	152.4	1037.0	7.1	3.1
Tionesta—Tionesta Creek	154.0	1043.0	1.6	3.8
West Hickory—West Hickory Run	159.8	1063.0	5.8	3.5
East Hickory—Hickory Creek	161.6	1069.0	1.8	3.3
Jones Run	164.4	1080.0	2.8	3.9
Tidioute—Tidioute Creek	169.5	1098.0	5.1	3.5
Magee	173.0	1108.0	3.5	2.9

TABLE No. 5—(Continued.)

DISTANCES, ELEVATIONS AND SLOPES ALONG ALLEGHENY RIVER.

Towns, mouths of tributaries and other points	Distance from mouth (Miles)	Elevation of water surface (Feet)	Distance between points (Miles)	Fall per mile between points (Feet)
Joe Thompson's Run	176.6	1123.0	3.6	4.2
Dunns Run	181.7	1142.0	5.1	3.7
Irvineton—Brokenstraw Creek	184.0	1149.0	2.3	3.0
Jackson's Run	187.0	1160.0	3.0	3.7
Warren—Conewango Creek	192.0	1174.0	5.0	2.8
Hemlock	197.0	1197.0	5.0	5.0
Big Bend	200.0	1208.0	3.0	3.7
Kinzua Creek	202.0	1211.0	2.0	1.5
Salamanca	233.0	1371.0	31.0	5.2
Great Valley Creek	233.8	1372.0	0.8	1.3
Tuneungwant Creek	240.5	1388.0	6.7	2.4
Nine Mile Creek	245.0	1400.0	4.5	2.7
Five Mile Creek	249.0	1416.0	4.0	4.0
Olean	254.0	1418.0	5.0	0.4
Olean Creek	254.5	1420.0	0.5	4.0
Oswayo Creek	260.7	1430.0	6.2	1.6
Port Allegany	284.7	1464.0	24.0	1.4
Coudersport	301.2	1640.0	16.5	10.7
Colesburg	308.0	1830.0	6.8	27.9
Point on river	312.9	2210.0	4.9	77.6
Head of stream	314.0	......	1.1	...

*Slackwater.
The lifts of the locks are as follows:
Lock No. 1................ 7.0 feet.
Lock No. 2................ 11.0 feet.
Lock No. 3................ 10.5 feet.

TOWNS AND POPULATION.

The following table shows the cities and towns of over 1200 population along the Allegheny River, with their respective distances by river from Pittsburgh.

TABLE No. 6.

PRINCIPAL CITIES AND TOWNS ALONG ALLEGHENY RIVER.

Name	Distance above mouth (Miles)	Population (1910)
Coudersport, Pa.	301	3100
Port Allegany, Pa.	285	1980
Eldred, Pa.	269	1240
Olean, N. Y.	254	14750
Allegany, N. Y.	251	1290
Salamanca, N. Y.	233	5800
Warren, Pa.	192	11080
Tidioute, Pa.	170	1300
Oil City, Pa.	134	15700
Franklin, Pa.	127	9800
Emlenton, Pa.	92	1110
Parker, Pa.	85	1240
East Brady, Pa.	71	1500
Kittanning, Pa.	46	4300
Ford City, Pa.	43	4900
Freeport, Pa.	30	2250
Tarentum, Pa.	22	7400
New Kensington, Pa.	18	7700
Springdale, Lock No. 3, Pa.	17	2000

TABLE No. 6—(Continued.)

PRINCIPAL CITIES AND TOWNS ALONG ALLEGHENY RIVER.

Name	Distance above mouth (Miles)	Population (1910)
Oakmont, Pa.	12	3440
Verona, Pa.	11	2850
Aspinwall, Pa.	7	2590
Sharpsburg, Pa.	6	8150
Etna, Pa.	5	5830
Millvale, Pa.	4	7860
Pittsburgh, Pa.	0	533905

MONONGAHELA RIVER.

GENERAL COURSE AND SLOPE.

The Monongahela River has its source, by its main tributary, the Tygart Valley River, in the southern part of Randolph County, West Virginia, and flows a distance of 246 miles, in a general northerly course, to Pittsburgh. The Tygart Valley has a length of 118 miles and joins with the West Fork to form the Monongahela, near the City of Fairmont. After flowing a distance of 36 miles from this point, the Monongahela enters the State of Pennsylvania, and continues 92 miles to Pittsburgh. The elevation of the source is 4100 feet, and from here the fall per mile by long reaches is as follows: To Elk Water River, 14 miles, 136.4 feet; thence to Sandy Creek, 76 miles, 15.6 feet; thence to Fairmont, 29 miles, 5.1 feet; thence to Pittsburgh, 127 miles, 1.2 feet. The average width of the stream between flow lines of the pools is as follows: From Fairmont to the mouth of the Youghiogheny, a distance of 112 miles, 600 feet; thence to the mouth, 15 miles, 870 feet.

PHYSICAL FEATURES.

Valley. Like the Allegheny, the Monongahela River has its headwaters in the high upland of the eastern portion of the basin, from which the run-off is rapid. The Tygart Valley River, which forms the headwaters, is not navigable, in the ordinary sense of the word, and flows for the greater distance in a narrow and rugged valley; a notable exception, however, being in a long reach above the town of Elkins, where the valley, between high hills, is wide, and much of the low-level land farmed or in grazing. The hills along the valley have a height above water, near the source, of about 950 feet, which decreases to about 500 feet near the mouth.

The flats are occupied by towns, and below Elkins, to some extent by railroads and coal mining interests. A considerable part of the stream is of rapid fall, and frequently large boulders, fallen from the slopes, are scattered over the bed, which for the most part is comparatively hard and not subject to material change. A detailed description of this stream will be found in Chapter VI.

The Monongahela River proper has its head 1.4 miles above Fairmont, W. Va., and from here flows through a valley, which is narrower than that of the Allegheny, but somewhat similar in topography. The channel and the bordering hills average lower above sea than along the Allegheny at the same distance above the Ohio. At the head the water has an elevation of 858 feet and falls from here, in a distance of 128 miles, at the rate of 1.2 feet per mile; while, in about the same distance, the Allegheny falls from an elevation of 959 feet at Franklin, at the rate of 2 feet per mile. The water elevation at the junction of the two streams is 703 feet.

The upland, close to the river, ranges in height above water from 500 to 600 feet

along the upper reaches to about 400 feet in the vicinity of the mouth. Bottom land is much less extensive than along the Allegheny, both the total amount and the average areas being smaller. From Fairmont to the Pennsylvania state line, the hills are close to the river, and only a few small areas are to be found; but below this point there are a number of stretches, some of them bordering the river for several miles. Upon nearing Pittsburgh, these flats become more extensive, in some cases having a width of about half a mile. The height of these flats above normal water of the pools averages about 30 feet, south of Brownsville, and north of that place about 27 feet. The railroads average about the same height.

Channel. The channel is not so firm as that of the Allegheny, as the formation is largely of clay and sand; but rock bottom, in the river bed, is present at occasional places. A considerable amount of bank cutting takes place, due to floods and also to scour of ice, which frequently forms in this river, but not to such extent, nor in such violent movement of large, solid masses as on the northern stream. These troubles in this stream would also be much reduced if the floods were checked and the flow made more uniform.

The following table shows distance from Pittsburgh, by river channel, to towns and to mouths of important tributaries, together with elevations of these places, and distance and fall per mile between points.

TABLE No. 7.

DISTANCES, ELEVATIONS AND SLOPES ALONG MONONGAHELA RIVER.

Towns, mouths of tributaries and other points	Distance from mouth (Miles)	Elevation of water surface (Feet)	Distance between points (Miles)	Fall per mile between points (Feet)
Mouth of river, Point bridge	0	703.0	...	
Lock No. 1	1.9	{703.0 / 707.4	1.9	
Becks Run	4.4	707.4	2.5	
Streets Run	6.1	707.4	1.7	
Lock No. 2	11.2	{707.4 / 715.2	5.1	
Turtle Creek	11.7	715.2	0.5	
Youghiogheny River	15.6	715.2	3.9	
Peters Creek	20.1	715.2	4.5	
Elizabeth	23.1	715.2	3.0	
Lock No. 3	23.9	{715.2 / 723.5	0.8	
Monongahela City	32.2	723.5	8.3	
Pigeon Creek	32.6	723.5	0.4	
Monessen	39.4	723.5	6.8	
Lock No. 4	41.2	{723.5 / 735.0	1.8	
Charleroi	41.9	735.0	0.7	
Maple Creek	42.5	735.0	0.6	
Bellevernon	43.8	735.0	1.3	
Fayette City	46.4	735.0	2.6	
Little Redstone Creek	46.8	735.0	0.4	
Roscoe	48.8	735.0	2.0	
Pike Run	51.5	735.0	2.7	
California	51.7	735.0	0.2	
Redstone Creek	55.2	735.0	3.5	
Brownsville	56.4	735.0	1.2	
Dunlap Creek	56.6	735.0	0.2	
Lock No. 5	58.8	{735.0 / 747.1	2.2	
Fredericktown	64.4	747.1	5.6	
Millsboro	65.5	747.1	1.1	

TABLE No. 7—(Continued.)

DISTANCES, ELEVATIONS AND SLOPES ALONG MONONGAHELA RIVER.

Towns, mouths of tributaries and other points	Distance from mouth (Miles)	Elevation of water surface (Feet)	Distance between points (Miles)	Fall per mile between points (Feet)
Ten Mile Creek	65.7	747.1	0.2	
Rice's Landing	68.5	747.1	2.8	
Lock No. 6	68.6	747.1 760.1	0.1	
East Riverside	73.0	760.1	4.4	
Muddy Run	73.1	760.1	0.1	
Gates—Middle Run	76.6	760.1	3.5	
Browns Run	77.5	760.1	0.9	
Little Whiteley Creek	78.8	760.1	1.3	
Whiteley Creek	80.5	760.1	1.7	
Lock No. 7	82.7	760.1 770.0	2.2	
Jacobs Creek	83.3	770.0	0.6	
Greensboro	84.6	770.0	1.3	
George Creek	85.2	770.0	0.6	
Dunkard Creek	87.5	770.0	2.3	
Lock No. 8	87.5	770.0 780.8	0.0	
Cheat River	89.9	780.8	2.4	
Point Marion	90.0	780.8	0.1	
State Line	91.6	780.8	1.6	
Crooked Run	91.9	780.8	0.3	
Lock No. 9	93.2	780.8 793.4	1.3	
Robinson Run	96.9	793.4	3.7	
Dents Run	100.0	793.4	3.1	
Morgantown	101.9	793.4	1.9	
Deckers Creek	102.2	793.4	0.3	
Lock No 10	102.6	793.4 804.7	0.4	
Scrafford	103.7	804.7	1.1	
Lock No. 11	105.0	804.7 815.3	1.3	
Booths Creek	105.3	815.3	0.3	
Lock No. 12	109.8	815.3 826.0	4.5	
Little Falls	110.5	826.0	0.7	
Lock No. 13	111.8	826.0 836.7	1.3	
Flaggy Meadow Run	112.9	836.7	1.1	
Lock No. 14	115.5	836.7 847.3	2.6	
Indian Creek	115.9	847.3	0.4	
Rivesville—Pow Pow Creek	122.4	847.3	6.5	
Lock No. 15	124.1	847.3 858.0	1.7	
Buffalo Creek	125.0	858.0	0.9	
Fairmont	126.7	858.0	1.7	
West Fork River	128.1	858.0	1.4	
Lost Run	137.3	900.0	9.2	4.6
Grafton	148.3	975.0	11.0	6.8
Pleasant Creek	153.5	995.0	5.2	3.8
Sandy Creek	156.1	1005.0	2.6	3.8
Teters Creek	161.0	1155.0	4.9	30.6
Laurel Creek	163.5	1240.0	2.5	30.4
Philippi	171.3	1292.0	7.8	6.7
Buckhannon River	176.5	1320.0	5.2	5.3
Middle Fork River	180.3	1498.0	3.7	47.5
Belington	188.0	1680.0	7.7	23.5
Beaver Creek	192.8	1750.0	4.8	14.7
Leading Creek	202.3	1880.0	9.5	13.3
Beverly	211.3	1990.0	9.0	12.2
Shavers Creek	219.0	2040.0	7.7	6.5

TABLE No. 7—(Continued.)

DISTANCES, ELEVATIONS AND SLOPES ALONG MONONGAHELA RIVER.

Towns, mouths of tributaries and other points	Distance from mouth (Miles)	Elevation of water surface (Feet)	Distance between points (Miles)	Fall per mile between points (Feet)
Huttonsville—Riffles Creek	224.0	2070.0	5.0	6.0
Elk Water River	232.3	2190.0	8.3	14.6
Valley Head—Windy Run	237.5	2460.0	5.2	51.4
Logan Run	239.0	2550.0	1.5	60.0
Mingo Flat	241.0	2690.0	2.0	70.0
Head of stream	245.8	4100.0	4.8	283.5

Note: The lifts of the locks are as follows:

Lock No. 1	4.40 feet.	Lock No. 9	12.35 feet
" " 2	7.70 "	" " 10	10.66 "
" " 3	8.00 "	" " 11	10.66 "
" " 4	11.50 "	" " 12	10.67 "
" " 5	12.10 "	" " 13	10.67 "
" " 6	13.05 "	" " 14	10.67 "
" " 7	9.20 "	" " 15	10.66 "
" " 8	10.60 "		

No notes of slope are given until above head of slackwater, which extends to 4 miles above Fairmont. Where slopes are given, the distances and elevations were determined from U. S. Geological Survey maps.

TOWNS AND POPULATION.

The following table shows the cities and towns of over 1,200 population along the Monongahela River, with their respective distances by river from Pittsburgh.

TABLE No. 8.

PRINCIPAL CITIES AND TOWNS ALONG MONONGAHELA RIVER.

Name	Distance above mouth (Miles)	Population (1910)
Elkins, W. Va.	203	5260
Belington, W. Va.	188	1490
Grafton, W. Va.	148	7560
Fairmont, W. Va.	127	9710
Morgantown, W. Va.	102	9150
Point Marion, Pa.	90	1390
Brownsville, Pa.	56	2330
California, Pa.	52	2230
Roscoe, Pa.	49	1450
Fayette City, Pa.	46	2010
Bellevernon, Pa.	44	2380
Charleroi, Pa.	42	9620
Monessen, Pa.	39	11780
Monongahela City, Pa.	32	7600
Elizabeth, Pa.	23	2320
McKeesport, Pa.	15	42690
Duquesne, Pa.	13	15730
Braddock, Pa.	10	19360
Rankin, Pa.	9	6040
Swissvale, Pa.	8.5	7380
Munhall, Pa.	8	5190
Homestead, Pa.	7.5	18710
West Homestead, Pa.	7	3010
Hays, Pa.	6	1890
Pittsburgh, Pa.	0	533905

OHIO RIVER.

GENERAL DESCRIPTION.

Course. The Ohio River is formed by the junction of the Allegheny and Monongahela Rivers at Pittsburgh, and flows in a general southwesterly course, emptying into the Mississippi River at Cairo, Ill., 967 miles below Pittsburgh. For the first 39.5 miles of its course, the river is entirely within the State of Pennsylvania, and in the remainder, forms the boundary line between the States of Ohio, Indiana and Illinois, on the north, and West Virginia and Kentucky on the south.

Basin. The drainage area of about 210,000 square miles lies in the central part of the eastern half of the United States and includes portions of the States of New York, Pennsylvania, Maryland, West Virginia, Virginia, North Carolina, Georgia, Alabama, Tennessee, Kentucky, Ohio, Indiana and Illinois. Its northern boundaries are within four miles of Lake Erie at one point, its southern boundaries are within 300 miles of the Gulf of Mexico, and its eastern boundaries are about 225 miles from the Atlantic Ocean. The sources of the tributaries from the north lie in the glaciated area; those of the southern tributaries, which are the larger and more numerous, are located on the steep and rocky slopes of the western side of the Appalachian Mountains.

The topography of the Ohio Basin varies from flat and rolling in the western and northern portions to rough and mountainous in the southern and eastern sections. The northern and western portions of the basin are largely deforested, but the southern and eastern portions are still covered with a heavy growth of timber, especially near the headwaters of the streams. The mean annual rainfall in the basin is about 45 inches, ranging from 35 inches along its northern boundary to 70 inches in the southeastern part, at the source of the Tennessee River.

Valley. From Pittsburgh to Louisville, 601 miles, the valley is only about 1 mile wide, at few places exceeding 2 miles in width. In the vicinity of Louisville, its width is about 4 miles, but below the mouth of Salt River it narrows abruptly to about 1 mile, and remains narrow for nearly 100 miles. Beyond this narrow stretch it broadens out to a width of 6 or 8 miles, which it maintains for much of its course to Cairo, except in passing the elevated ridge below Shawneetown, Ill., where its width is reduced to about 2.5 miles. In the lower 188 miles of its course, from the mouth of the Green River to the Mississippi, the character of the Ohio changes, and the stream in its general characteristics resembles the lower Mississippi.

In general, the rock floor of the valley is from 30 to 50 feet below the level of the stream at low water, and at a few points is from 65 to 75 feet below the stream. The depth of the valley ranges from about 100 feet to 600 feet, being greatest along the northern part of West Virginia, and least in the portion near the mouth, where the valley is widest. The width and depth of the Ohio valley are notably less than should have been accomplished by erosive action since the beginning of the development of the drainage lines, and this fact is explained by recent investigations, which indicate that the basin of the Ohio has been enlarged in its upper portion, owing to the geologically recent union of several independent drainage systems, formerly discharging into the Lake Erie Basin.

Channel. In its upper portion, the bed of the river is composed of coarse gravel and boulders, and in places rock; but proceeding downstream, the gravel and boulders gradually disappear and the bed becomes sandy. The minimum width of the river in its upper reaches is only about 1200 feet, and while it widens considerably at numerous points, the general width does not increase materially from Pittsburgh to Cincinnati. In the long pool above the falls of the Ohio at Louisville, the average width is much greater than that

above Cincinnati, while just below the falls there is a considerable narrowing. Below this the average width continues to increase toward the mouth of the river. The maximum width between banks is found about 20 miles above the mouth, where it is considerably over a mile. There are many islands in the river, more than 50 above Louisville and about 30 below, ranging in size from a few acres to 5000 acres. These islands are for the most part permanent in position, but a number have been considerably reduced in size by the cutting of the floods, and some have partly or wholly disappeared.

The total fall between Pittsburgh and Cairo is 430 feet, or an average of 0.445 foot per mile. This descent is made up of a series of shoals and riffles, separated by pools with deeper water, and slopes sometimes less than one inch per mile. The surveys of the U. S. Engineers show that there are 187 pools with over 7 feet at low water, aggregating 632 miles in length. The greatest fall is at the Louisville rapids, where there is a drop of 23.0 feet in 2.25 miles, or 10.25 feet per mile.

Discharge. In quantity of discharge the Ohio River is the main tributary of the Mississippi. Its mean annual discharge at the mouth is about 300,000 second-feet, and its maximum discharge is approximately 1,500,000 second-feet, or about 30 times the low-water flow. A comparison of records of flow of the Ohio River with those of the upper Mississippi and Missouri shows that, although its drainage area is only one-third that of the combined Mississippi and Missouri, its mean and low-water discharges are 1.3 times as great as their combined flow, and its maximum discharge is 1.5 times as great. This fact is accounted for by the greater rainfall within the Ohio watershed and by the general character of its basin.

The minimum discharge at Pittsburgh is about 1200 second-feet, or 0.063 second-foot per square mile of drainage area. The maximum discharge is about 434,000 second-feet, or 23 second-feet per square mile.

NAVIGATION.

The Ohio is generally navigable throughout the entire season for boats of less than 3 feet draft, while during a few months in the early part of the season, it is navigable for boats of 6 feet draft, although there is usually little traffic with such boats after July. Navigation is interrupted by ice for periods averaging from 10 to 12 days a year. The canal at Louisville affords opportunity for passing around the rapids during low water. During high stages the boats are able to pass over the rapids.

The proposed improvement of the Ohio to give a nine-foot stage from Pittsburgh to Cairo by means of locks and dams involves the ultimate construction of 54 dams at an estimated cost of $63,731,488, in addition to the amount appropriated and authorized prior to March 2, 1907, or a total cost of $73,012,864. Up to August 1, 1911, 12 of these dams had been completed and 11 others were under construction.

All the principal tributaries of the Ohio are navigable, and have been improved by the United States, either by locks and dams or by improvement of the open channel.

PRINCIPAL TRIBUTARIES.

The drainage areas of the principal tributaries are shown in the following table, together with the elevations of their mouths, their distances below Pittsburgh and the fall of the Ohio between these points. Below the Beaver River, low-water elevations of open rivers are used; above this point, pool elevations are given.

TABLE No. 9.

PRINCIPAL TRIBUTARIES OF OHIO RIVER.

Stream	Enters Ohio from	Distance from Pittsburgh (Miles)	Elevation mouth (Feet)	Fall of Ohio between streams (Feet)	Fall of Ohio per mile (Feet)	Drainage area (Sq. miles)
Allegheny	North		703			11,580
Monongahela	South		703			7,340
Beaver	North	26	668	35	1.35	3,021
Muskingum	North	172	565	103	0.71	7,797
Little Kanawha	South	184	562	3	0.25	2,288
Kanawha	South	265	515	47	0.58	12,197
Big Sandy	South	317	487	28	0.54	3,950
Scioto	North	355	472	15	0.40	6,630
Licking	South	468	432	40	0.36	3,269
Miami	North	489	428	4	0.19	5,247
Kentucky	South	543	408	20	0.37	6,630
Green	South	779	332	76	0.32	8,575
Wabash	North	840	314	18	0.30	33,725
Cumberland	South	910	291	23	0.33	18,573
Tennessee	South	922	287	4	0.33	39,050
Ohio at Cairo		967	273	14	0.32	210,000

Other important tributaries are the Little Beaver, Big Hocking, Shade, Raccoon, Guyandotte, Big Scioto, Licking, Big Miami, Salt, Saline and Tradewater.

RESOURCES.

The Ohio Basin is rich in agricultural and mineral resources, and is traversed by a network of railroad lines. The Pittsburgh coal extends along the Ohio from a point about 75 miles below Pittsburgh, a short distance above Wheeling, W. Va., to a point about 285 miles below Pittsburgh, a short distance below Point Pleasant, W. Va. The lower measures extend to a point about 320 miles below Pittsburgh, terminating just above Portsmouth, Ohio. From a point about 788 miles to a point about 875 miles below Pittsburgh, or from about Cannelton, Ind., to Elizabethtown, Ill., the Ohio flows through the southern end of the "Eastern Region" coal field, which lies largely in Illinois, Indiana and Kentucky.

POPULATION.

The total population in the basin is estimated at about 12,000,000, while the total population of the towns along the banks of the river is about 1,776,000. The river is bordered with prosperous manufacturing towns, the principal of which are given in the following table, together with their distances below Pittsburgh and their populations in 1910.

TABLE No. 10.

POPULATION OF CITIES AND TOWNS ON OHIO RIVER FROM PITTSBURGH TO CAIRO.

City or town	Distance below Pittsburgh (Miles)	Population (1910)
Pittsburgh, Pa.		533,905
Bellevue, Pa.	4.7	6,323
Coraopolis, Pa.	10.4	5,252
Baden, Pa.	20.3	601
Freedom, Pa.	23.5	3,060
Rochester, Pa.	24.6	5,903
Beaver, Pa.	26.0	3,456
East Liverpool, O.	43.8	20,387
Wellsville, O.	47.2	7,769
Empire, O.	55.1	509
New Cumberland, W. Va.	56.2	1,807
Toronto, O.	58.7	4,271
Steubenville, O.	67.6	22,391
Mingo Junction, O.	70.5	4,049
Wellsburg, W. Va.	73.9	4,189
Brilliant, O.	74.0	742
Martins Ferry, O.	87.7	9,133
Bridgeport, O.	89.1	3,974
Wheeling, W. Va.	89.6	41,641
Benwood, W. Va.	93.8	4,976
Bellaire, O.	94.0	12,946
McMechens, W. Va.	95.3	2,921
Moundsville, W. Va.	101.5	8,918
Powhatan Point, O.	109.4	386
Clarington, O.	116.9	784
New Martinsville, W. Va.	127.6	2,176
Sistersville, W. Va.	137.4	2,684
Friendly, W. Va.	.....	217
New Matamoras, O.	142.0	711
St. Marys, W. Va.	154.8	1,358
Henderson, W. Va.	.....	286
Marietta, O.	171.4	12,923
Parkersburg, W. Va.	183.0	17,842
Ravenswood, W. Va.	219.8	1,081
Ripley, W. Va.	.....	591
Racine, O.	241.0	540
Pomeroy, O.	249.6	4,023
Mason, W. Va.	249.6	784
Hartford, W. Va.	.....	358
Middleport, O.	251.5	3,194
Point Pleasant, W. Va.	264.5	2,045
Gallipolis, O.	269.2	5,560
Crown City, O.	290.4	295
Athalia, O.	.....	226
Proctorsville, O.	304.2	577
Guyandot, W. Va.	304.5	1,702
Huntington, W. Va.	307.6	31,161
Ceredo, W. Va.	314.2	1,215
Kenova, W. Va.	315.1	992
Catlettsburg, Ky.	316.6	3,520
South Point, O.	.....	316
Ashland, Ky.	321.9	8,688

City or town	Distance below Pittsburgh (Miles)	Population (1910)
Coal Grove, O.	.....	1,759
Ironton, O.	326.7	13,147
Russell, Ky.	.....	1,038
Hanging Rock, O.	329.0	662
Greenup, Ky.	335.4	680
Portsmouth, O.	355.2	23,481
Quincy, Ky.	365.8	285
Vanceburg, Ky.	377.0	1,145
Concord, Ky.	389.3	213
Manchester, O.	395.8	1,966
Aberdeen, O.	.....	568
Maysville, Ky.	407.2	6,141
Ripley, O.	416.4	1,840
Dover, Ky.	418.5	386
Augusta, Ky.	425.8	1,787
Bradford, Ky.	.....	330
Foster, Ky.	437.1	158
Neville, O.	437.5	200
Moscow, O.	440.3	327
California, Ky.	446.0	248
New Richmond, O.	448.5	1,733
Newport, Ky.	468.2	30,309
Cincinnati, O.	468.2	363,591
Covington, Ky.	468.8	53,270
North Bend, O.	484.1	560
Ludlow, Ky.	.....	4,163
Lawrenceburg, Ind.	491.1	3,930
Aurora, Ind.	494.8	4,410
Rising Sun, Ind.	504.1	1,513
Patriot, Ind.	517.0	340
Warsaw, Ky.	525.8	900
Vevay, Ind.	535.2	1,256
Ghent, Ky.	535.2	421
Carrollton, Ky.	543.4	1,906
South Carrollton, Ky.	.....	365
Brooksburg, Ind.	548.5	150
Milton, Ky.	554.8	355
Hanover, Ind.	.....	356
Madison, Ind.	555.5	6,934
Jeffersonville, Ind.	600.5	10,412
Louisville, Ky.	601.5	223,928
New Albany, Ind.	605.0	20,629
West Point, Ky.	627.5	782
Brandenburg, Ky.	643.1	482
Mauckport, Ind.	645.2	279
Leavenworth, Ind.	661.1	690
Alton, Ind.	675.9	161
Stephensport, Ky.	697.4	205
Cloverport, Ky.	707.7	1,403
Cannelton, Ind.	720.2	2,130
Hawesville, Ky.	720.3	1,002
Tell City, Ind	723.4	3,369

TABLE No. 10—(Continued.)

POPULATION OF CITIES AND TOWNS ON OHIO RIVER FROM PITTSBURGH TO CAIRO.

City or town	Distance below Pittsburgh (Miles)	Population (1910)	City or town	Distance below Pittsburgh (Miles)	Population (1910)
Troy, Ind.	727.2	510	Cave in Rock, Ill.	871.5	306
Lewisport, Ky.	734.0	596	Elizabethtown, Ill.	879.7	633
Grandview, Ind.	738.1	735	Carrsville, Ky.	884.5	298
Rockport, Ind.	742.6	2,736	Rosiclare, Ill.	.....	609
Evansville, Ind.	746.9	69,647	Golconda, Ill.	892.3	1,088
Owensboro, Ky.	752.1	16,011	Smithland, Ky.	909.9	557
Newburg, Ind.	772.9	1,097	Paducah, Ky.	924.1	22,760
Henderson, Ky.	798.0	11,452	Hamletsburg, Ill.	.....	215
Mount Vernon, Ind.	822.9	5,563	Brookport, Ill.	926.9	1,443
Uniontown, Ky.	835.7	1,356	Metropolis, Ill.	932.9	4,655
Shawneetown, Ill.	848.9	1,863	Olmstead, Ill.	.....	288
Caseyville, Ky.	861.9	230	Mound City, Ill.	961,7	2,837
Tolu, Ky.	876.7	180	Cairo, Ill.	966.8	14,548

CHAPTER III.

FLOODS ON THE ALLEGHENY AND MONONGAHELA BASINS.

Introduction—Table of Floods—Monthly Distribution — Increase in Frequency and Height—Causes—Possible Maximum Flood—Description of Principal Floods—Relation of Allegheny and Monongahela Rivers to Floods at Pittsburgh.

INTRODUCTION.

The City of Pittsburgh, located at the confluence of two rivers, both subject, often simultaneously, to severe freshets, has naturally been repeatedly visited by disastrous floods. Since 1806, the rivers at Pittsburgh have crossed the danger mark, or 22-foot stage, 78 times, and the 30-foot stage 15 times, with an alarming increase in frequency, height and damage, culminating in the great flood of March 15, 1907, when the record stage of 35.5 feet was reached. The following table, obtained through the courtesy of the Local Forecaster, United States Weather Bureau, Pittsburgh, shows the dates and gage heights of these floods.

TABLE No. 11.

Record of Floods at Pittsburgh. Flood Stage, 22.0 feet.*

Year	Day of month		Gage Ht. (Feet)	Year	Day of month		Gage Ht. (Feet)
1806	April	10	33.9	1888	July	11	22.0
1810	November	9	32.0	1888	August	22	26.0
1813	January		29.0	1889	June	1	24.0
1816	February		33.0	1890	March	23	24.3
1832	February	10	35.0	1890	May	24	22.0
1840	February	1	26.8	1891	January	3	23.2
1846	March	15	25.0	1891	February	18	31.3
1847	February	2	26.9	1892	January	15	23.0
1847	December	12	24.0	1893	February	8	24.0
1848	December	22	23.0	1893	February	11	22.0
1851	September	20	30.9	1894	May	22	23.2
1852	April	6	25.0	1895	January	8	25.8
1852	April	19	31.9	1896	July	26	23.0
1858	May	27	26.0	1897	February	24	29.5
1859	April	28	22.0	1898	March	24	28.9
1860	April	12	29.7	1899	March	6	22.0
1860	November	4	22.0	1900	November	27	27.7
1861	September	29	31.0	1901	April	7	22.1
1862	January	21	30.0	1901	April	21	27.5
1862	April	22	27.9	1901	December	16	25.8
1865	March	4	24.5	1902	March	1	32.4
1865	March	18	31.4	1903	February	5	24.0
1867	February	15	22.0	1903	March	1	28.9
1867	March	13	23.5	1904	January	23	30.0
1868	March	18	22.0	1904	March	4	26.9
1873	December	14	25.7	1904	March	8	23.2
1874	January	8	22.2	1905	March	22	29.0
1876	September	19	25.0	1905	December	4	23.5
1877	January	17	24.6	1907	January	20	23.3
1878	December	11	24.5	1907	March	15	35.5
1881	February	11	23.2	1907	March	20	22.4
1881	June	10	27.1	1908	February	16	30.7
1883	February	5	24.8	1908	March	20	27.3
1883	February	8	28.0	1909	February	25	22.3
1884	February	6	33.3	1909	May	1	22.2
1885	January	17	23.0	1910	January	19	22.8
1886	April	7	22.8	1910	May	1	22.0
1887	February	12	22.0	1911	January	15	23.8
1887	February	27	22.0	1911	January	31	25.2

*Market Street gage.

MONTHLY DISTRIBUTION.

The authentic records extend back to 1872, and since this date 53 floods, ranging from the 22.0 to the 35.5-foot stage, have occurred. The following table gives the monthly distribution of the floods since 1872, and shows that the three principal flood months are February, March and January, and that February leads in point of number and March in point of average height; 13, or 24.5 per cent of the 53 floods having occurred in the former, while the average gage height for the 11 March floods is 27.4 feet. No floods have occurred in September or October during this period.

TABLE No. 12.

Monthly Distribution of Floods at Pittsburgh. December 14, 1873 to January 31, 1911.

Month	No. of floods	Per cent of total	Average stage
February	13	24.5	25.9
March	11	20.7	27.4
January	11	20.7	24.3
December	4	7.6	24.9
May	4	7.5	22.4
April	3	5.7	24.1
June	2	3.8	25.5
August	2	3.8	25.5
July	2	3.8	22.5
November	1	1.9	27.7
September	0	...	....
October	0	...	....
Total	53	100.0	25.3

CAUSES.

The causes of floods may be classified under two general headings: Natural, and Artificial.

NATURAL CAUSES.

The principal natural cause is heavy and concentrated precipitation. The magnitude of a flood caused by such a rainfall is dependent upon the condition of the ground. When a heavy precipitation occurs with the ground dry and parched, as in late summer, the ground naturally absorbs the first part of the rainfall, and the rain must be of considerable intensity and duration before the ground can be thoroughly soaked and a high rate of run-off take place. When rain falls upon frozen or icy ground, however, there is little or no penetration and practically all the precipitation flows off at once and causes high stages. This run-off is considerably increased if the ground is covered with snow, especially if the temperatures are high and the snow is soft and easily melted. It is considerably decreased where there are good conditions of forest and humus cover.

A study of the records of precipitation over the Allegheny and Monongahela Basins fails to disclose any increase in amount or intensity of rainfall during the period for which flood records are available. It is evident, therefore, that the increase in the frequency and height of floods is due to artificial causes.

ARTIFICIAL CAUSES.

Artificial causes may in general be of two kinds, the one causing a higher rate of run-off for a given rainfall, and the other causing a higher stage for a given discharge. It is generally believed that extensive deforestation of the drainage area of the two rivers,

by giving a higher rate of run-off, has been the cause, in part, of the increase in the frequency and height of floods along the Allegheny, Monongahela and Ohio Rivers. This subject is fully discussed in Appendix No. 1 of this report. It is well known, moreover, that the carrying capacity of the river channels at Pittsburgh has been considerably reduced in the last fifty years and that floods of a given discharge now reach a higher stage than formerly. The erection of bridge piers in the channel and of bridge abutments extending, in some cases, a considerable distance beyond the former bank lines is recognized as reducing to some extent the carrying capacity of the river channel. The extent to which these reductions have taken place is discussed in the following chapter.

The construction of the navigation dams has also, to a certain degree, raised the stage at which a flood of a given discharge passes Pittsburgh. The Davis Island dam on the Ohio and the Herr Island dam on the Allegheny, it is true, are movable dams, and when their wickets are lowered, as during floods, they offer little or no obstruction to discharge. The Monongahela dams, however, being fixed dams, are naturally greater obstructions to the passage of floods than the Herr Island and Davis Island dams. The Davis Island dam, while it does not materially raise the stage of the crest of high floods, has a tendency, nevertheless, to lengthen the time at which floods are at a high stage, for the reason that the wickets are of course not lowered until there is a sufficient flow to give a navigable depth in the pool with the wickets down, so that navigation will not be suspended and river craft will not go aground. As a result, the first part of a flood descends upon a stage several feet higher than would obtain with open river conditions, and the first part of the flood wave rises sooner and higher than it otherwise would. As fully discussed later, in Chapter VIII, the dams would have a considerable backwater effect during floods if any comprehensive dredging of the channel were carried out, and it would be necessary to rebuild them with the required sill elevations if the full flood-lowering effect of such dredging were desired.

INCREASE IN FREQUENCY AND HEIGHT.

That floods are increasing in frequency and height is evident from an inspection of the following table, which gives, by five-year periods, the number of floods of various heights since 1871.

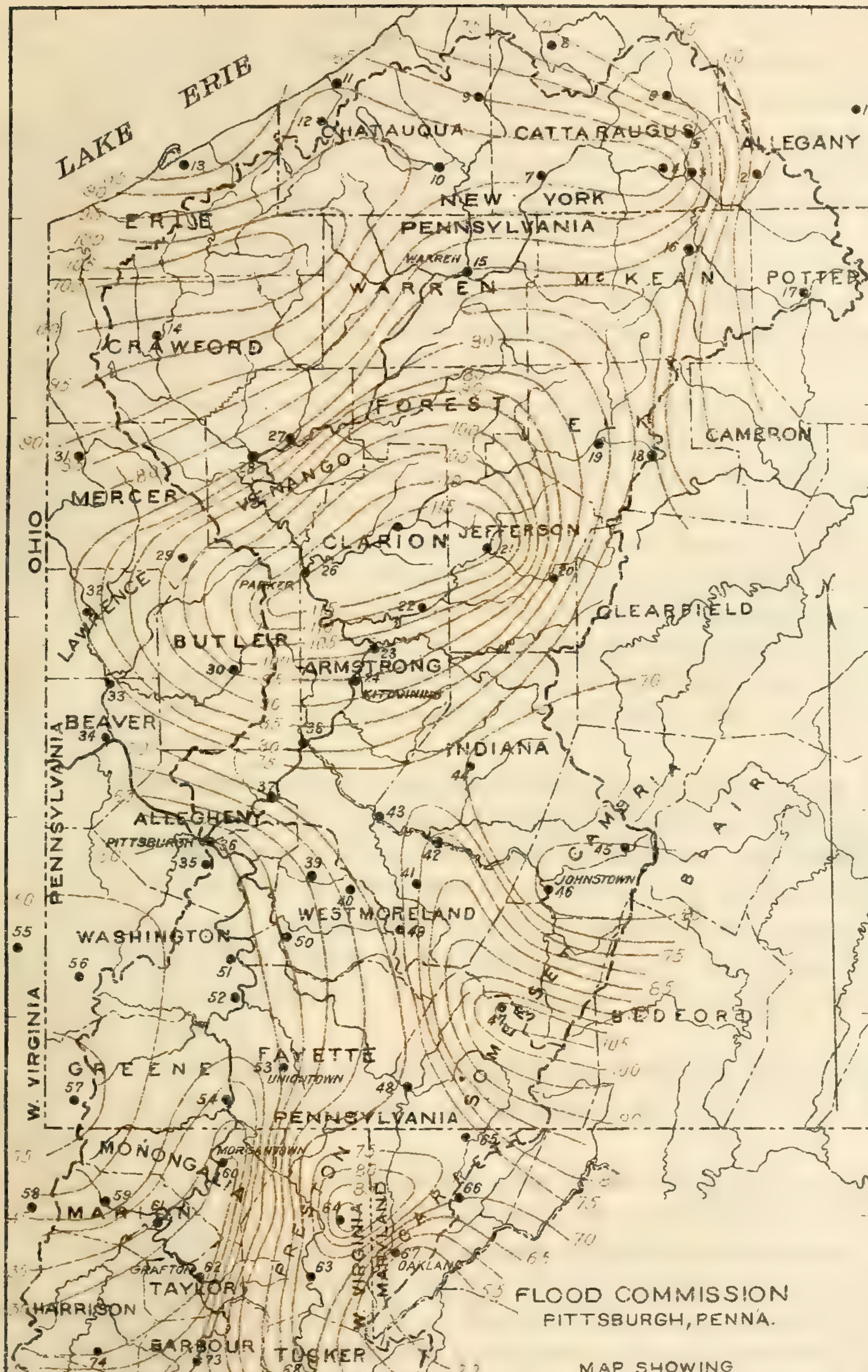
TABLE No. 13.

Increase of Floods at Pittsburgh since 1871, by Five-year Periods.

Five-year period	Number of floods				
	22 ft. to 26 ft.	26 ft. to 30 ft.	30 ft. to 35 ft.	35 ft. to 40 ft.	Total
1871–1875	2	0	0	0	2
1876–1880	3	0	0	0	3
1881–1885	3	2	1	0	6
1886–1890	7	1	0	0	8
1891–1895	6	0	1	0	7
1896–1900	2	3	0	0	5
1901–1905	5	4	2	0	11
1906–1910 (Inclusive Jan. 31, '11)	8	1	1	1	11
Total	36	11	5	1	53

POSSIBLE MAXIMUM FLOOD AT PITTSBURGH.

As inferred later, in the description of the 1907 flood, it is not only possible, but probable that Pittsburgh will some time be visited by a greater flood. The following



FLOOD COMMISSION
PITTSBURGH, PENNA.

MAP SHOWING
LINES OF EQUAL SNOWFALL
DECEMBER 1, 1909 TO FEBRUARY 28, 1910.

TOTAL SNOWFALL, INCHES.

1	Alfred	N.Y.	
2	Bolivar	" "	56
3	Olean	" "	
4	Allegany	" "	94
5	Humphrey	" "	
6	Franklinville	" "	70
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	
11	Westfield	" "	
12	Volusia	" "	
13	Erie	Pa.	83
14	Saegerstown	"	
15	Warren	"	72
16	Smethport	"	
17	Coudersport	"	
18	St. Marys	"	72
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	118
22	Hawthorn	"	
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	118
26	Parkers L'ndg.	"	
27	Oil City	"	
28	Franklin	"	76
29	Grove City	"	
30	Butler	"	
31	Greenville	"	90
32	Skidmore	"	
33	Elwood Jct.	"	
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	47
37	Springdale	"	
38	Freeport	"	
39	Irwin	"	
40	Greensburg	"	
41	Derry	"	
42	Blairsville	"	
43	Saltsburg	"	
44	Indiana	"	68
45	Cassandra	"	
46	Johnstown	"	62
47	Somerset	"	109
48	Confluence	"	
49	Lycippus	"	75
50	West Newton	"	
51	Lock No 4	"	
52	California	"	
53	Uniontown	"	53
54	Greensboro	"	
55	Wellsburg	W.Va.	
56	Claysville	Pa.	52
57	Aleppo	"	57
58	Smithfield	W.Va.	
59	Mannington	"	45
60	Morgantown	"	29
61	Fairmont	"	32
62	Grafton	"	31
63	Rowlesburg	"	
64	Terra Alta	"	94
65	Grantsville	Md.	70
66	Deer Park	"	71
67	Oakland	"	49
68	Parsons	W.Va.	69
69	Elkins	"	42
70	Beverly	"	
71	Pickens	"	117
72	Buckhannon	"	43
73	Phillipi	"	44
74	Lost Creek	"	30
75	Weston	"	47

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review of the weather conditions during the winter of 1909-1910, when such an unprecedented amount of snow fell, is interesting in this connection.

December, 1909, was the coldest December on record. There were no extremely low temperatures recorded, but the low average was due to the long duration of the cold weather. The smaller rivers were frozen by the 15th and remained frozen for the rest of the month. There was a heavy fall of snow all over the two basins. In the mountain sections and in the northern portions, snowfall was somewhat heavier than is usual in December. The range in depth in the Pennsylvania section of the basin was from 8 to 28 inches, in the New York section from 8 to 16 inches, and in the Maryland section from 18 to 30 inches. In West Virginia it was the heaviest recorded in any one month, ranging from 6 to 35 inches in depth.

During the entire month of January the ground was frozen and covered with snow. There was an extraordinary snowstorm on the 5th and 6th. The snowfall during the month was from 24 to 57 inches in Pennsylvania, from 10 to 43 inches in West Virginia, and from 20 to 30 inches in western Maryland. Although exceptionally cold weather prevailed from the 6th to the 11th, the average temperature for the month was slightly above the normal. There were alternate warm and cold periods of short duration, the two mildest being at the first and last of the month. These periods of moderately warm weather, however, were not sufficient to melt off the very great accumulation of the December and January snowfall, and at the end of the month snow lay on the ground to a depth of 25 inches over parts of western Pennsylvania and 10 to 20 inches over most of West Virginia.

In February there were two unusually heavy snowstorms, on the 11th and 12th, and on the 17th and 18th. The total snowfall for the month was from 25 to 40 inches in the portion of the basin lying in New York, 15 to 44 inches in the Pennsylvania section, 10 to 40 inches in the West Virginia section, and 10 to 17 inches in the Maryland section.

This gave a total snowfall for December, January and February of from 56 to 94 inches in the New York section of the basin, from 47 to 117 inches in the Pennsylvania section, from 30 to 117 inches in the West Virginia section, and from 50 to 70 inches in the Maryland section.

The above information is collected from the monthly bulletins of the U. S. Weather Bureau. The map, Plate 1, shows the depth and distribution of the total snowfall for the above period.

On account of the unusual and alarming amount of snow remaining on the ground at the end of February, grave apprehension was felt by those in touch with the conditions as to the possibility of a flood at Pittsburgh considerably exceeding that of March 15, 1907. It was not unreasonable to suppose that the heavy warm rains that so frequently occur during the last of February or the month of March might occur at this time, when the conditions on the watershed were ripe for an unprecedentedly high rate of run-off. Fortunately, however, the rain of the 27th and 28th of February was comparatively light, and March had a remarkably light precipitation, which was scattered through the month in ineffectual showers, the total for the month over the entire drainage area being in general considerably under one inch. The month of March, however, had an unusually high temperature, which prevailed almost continuously throughout the month. As a result, the deep snow melted off rapidly, but with no additional run-off due to rainfall; and while the streams were flowing full during the latter part of February and the first part of March, the waters did not rise high enough to do serious damage, the highest stage reached at Pittsburgh being only 22.0 feet on March 1st. The water fell rapidly after

the first part of March and by the end of the month had dropped to the 3.5-foot stage. The U. S. Engineers raised the wickets on the movable dams to facilitate navigation, this being the earliest date it has ever been necessary to use the slackwater facilities.

If a rain similar to any one of the frequent heavy, warm spring rains had occurred at this critical time, for example, similar to that of March 1-4, 1904, which caused a flood stage of 26.9 feet at Pittsburgh, the snow on the ground at the end of February, 1910, would have melted and run off with this rain, and a very conservative estimate, made graphically by means of the diagram, Plate 83, places the probable Pittsburgh stage at 38.3 feet. (See Chapter VII.) A flood of this height, giving a discharge of about 560,000 second-feet, or 30 second-feet per square mile, would inundate 1820 acres at Pittsburgh and the damage might amount to ten million dollars.

As the snow run-off from only 62 per cent of the drainage area was used in this diagram, it is not unreasonable to suppose that a gage height of 40 feet might have been reached if the entire drainage area had been considered. In fact, if the maximum recorded discharges of the Kiskiminetas, Allegheny, Monongahela and Youghiogheny Rivers were assumed to arrive at Pittsburgh simultaneously, a discharge of 634,000 second-feet, equivalent to a gage height of about 39.8 feet, would result.

The following, quoted from the annual report of the Water Supply Commission of Pennsylvania for 1907, is interesting in this connection:

"That greater floods may be expected at Pittsburgh is suggested by a comparison of records of the Ohio and Susquehanna Rivers. These two streams drain at Wheeling, W. Va., and at Harrisburg, Pa., respectively 23,800 and 24,030 square miles, areas approximately equal. If conditions of rainfall, forest cover, topography, geology, development and industry were alike in the two basins, flood discharges approximately equal at these two points might be expected. The Susquehanna drainage basin is subject to a rainfall of 41 inches, while the Ohio basin receives 41.2 inches. The topography does not differ essentially, each stream having certain tributaries leading from the glaciated areas and regulated by lakes, ponds and swamps, and both draining the sides of the Allegheny Mountains, through other tributaries. The records show that the great rain of May and June, 1889, resulted in a run-off at Harrisburg, in the Susquehanna River, of 29.2 cubic feet per second per square mile, while during the flood of March, 1907, the Ohio at Wheeling reached but 20 cubic feet per second per square mile. What a discharge of 30 cubic feet per second per square mile at Pittsburgh would mean in damage and loss of life cannot be foretold."

PRINCIPAL FLOODS.

The notable floods between 1873, when the authentic records begin, and 1898, are those of February 6, 1884, 33.3 feet, February 18, 1891, 31.3 feet and February 24, 1897, 29.5 feet. Prior to 1873, detailed data as to rainfall and river stages are not available, and no discussion can be made of earlier floods. After 1897 more complete data are on record, enabling fuller discussion and analysis of the principal floods occurring since that date.

FLOOD OF FEBRUARY 6, 1884.

The flood of February 6, 1884, reached a stage of 31.9 feet at Pittsburgh at 8 A. M. and must have reached its maximum of 33.3 feet some time before midnight, when it began to slowly recede, having fallen to the 31.7-foot stage at 8 A. M. on the 7th. The only river stages on the Allegheny and Monongahela Basins available for this time are those at Pittsburgh, Freeport and Confluence. Freeport reached its maximum of 30.0 feet, only 2.7 feet below record stage, on the morning of the 6th. The Youghiogheny at Confluence rose to 9.9 feet on the 5th, 8.7 feet below its maximum in the 1907 flood. Unfortunately, no record of the stage at Lock No. 4 on the Monongahela is available, but it must have been lower than the 1907 crest of 37.4 feet, for during the 1884 flood, the Freeport maximum was 2.0 feet higher than the 1907 crest, while the Pittsburgh stage was 2.2 feet lower. Had the Monongahela and Yough-

iogheny equaled their 1907 crests during this flood the Pittsburgh stage would undoubtedly have exceeded that of 1907.

During this flood, the Ohio at Wheeling and Cincinnati reached the highest stage ever recorded at these points. Table No. 14 gives the gage heights on record for river stations on the Allegheny, Monongahela and Ohio Rivers. In this and the following tables the stages of the Ohio at Wheeling, Parkersburg and Cincinnati are included, in order to show the relation between the Pittsburgh stage and that at points further down the Ohio.

TABLE No. 14.

Daily Gage Heights at River Stations. Flood of February 6, 1884.

Station	Date											Highest recorded stage	
	January		February										
	30	31	1	2	3	4	5	6	7	8	9	Stage	Date
Freeport	5.7	8.8	12.2	11.5	11.5	9.2	14.0	30.0	28.5	22.4	18.7	32.7	Feb. 18, 1891
Confluence	0.7	5.7	5.8	4.2	3.4	3.2	9.9	9.5	8.9	7.2	5.2	18.6	Mar. 14, 1907
Pittsburgh	3.3	8.4	20.4	17.3	12.8	11.1	15.8	a 31.9	31.7	26.3	21.3	35.5	Mar. 15, 1907
Wheeling	----	----	----	----	----	20.0	23.0	38.0	b 46.5	46.5	41.3	53.1	Feb. 7, 1884
Marietta (c)	20.0	21.5	21.5	25.5	28.3	25.2	29.0	37.7	46.2	49.5	52.0	----	

a. Max. 33.3. b. Max. 53.1, 2 P.M. c. No gage heights for Parkersburg available.

FLOOD OF FEBRUARY 18, 1891.

The flood of February 18, 1891, which reached a maximum of 31.3 feet at Pittsburgh, was the first considerable flood since 1884. It was caused principally by the extraordinarily high discharge of the Allegheny, the stage at the Freeport gage reaching the record height of 32.7 feet, while the Monongahela at Lock No. 4 rose to only 21.8 feet, 20 feet below record stage. The West Fork and Cheat Rivers did not rise at all, but the Youghiogheny had a considerable flood, rising to 18.6 feet at West Newton.

The following table gives the gage heights at river stations during this flood.

TABLE No. 15.

Daily Gage Heights at River Stations. Flood of February 18, 1891.

Station	Date										Highest recorded stage	
	February											
	12	13	14	15	16	17	18	19	20	21	Stage	Date
Brookville	2.0	1.2	0.8	0.5	2.5	10.0	9.0	4.2	1.8	2.0	14.0	June 1, 1889
Clarion	3.7	3.7	3.7	3.5	4.0	11.7	13.0	8.0	6.6	6.3	16.0	Mar. 20, 1905
Saltsburg	3.5	3.0	2.6	2.2	3.0	18.5	11.5	6.0	4.5	5.0	22.1	1859
Warren	4.3	3.9	3.1	2.9	2.6	11.0	12.0	11.3	10.0	9.7	17.4	Mar. 1865
Oil City	5.4	4.3	3.9	3.5	3.5	13.8	15.9	13.5	10.9	10.4	21.0	Mar. 17, 1865
Parker	7.4	6.0	5.2	4.4	4.0	12.0	20.7	17.0	13.0	11.0	28.0	Mar. 1865
Freeport	12.5	10.4	8.9	7.8	7.6	23.4	32.7	27.0	20.0	19.0	32.7	Feb. 18, 1891
Rowlesburg	5.0	5.0	5.0	5.0	5.0	5.7	6.0	5.5	5.3	5.3	22.0	July 10, 1888
Confluence	6.1	5.5	4.9	4.3	6.9	12.3	10.2	6.9	6.0	6.2	18.6	Mar. 14, 1907
West Newton	6.6	5.1	4.1	3.7	5.5	18.6	13.2	8.6	6.4	8.2	28.2	Mar. 14, 1907
Weston	3.0	3.0	2.5	3.0	3.5	3.0	3.0	2.5	4.0	4.4	21.0	Oct. 13, 1890
Greensboro	13.0	11.0	10.2	9.8	10.0	14.0	13.5	12.0	11.5	12.0	39.0	July 10, 1888
Lock No. 4	18.8	13.8	11.8	11.4	12.3	21.8	20.5	16.3	14.0	16.5	42.0	July 11, 1888
Pittsburgh	16.7	12.6	10.4	9.2	9.3	24.2	31.3	26.5	19.5	18.6	35.5	Mar. 15, 1907
Wheeling	27.6	23.0	17.8	14.0	16.0	25.0	40.0	44.6	40.5	34.5	53.1	Feb. 7, 1884
Parkersburg	26.2	26.9	23.3	19.6	16.0	27.0	34.5	41.4	44.3	44.6	53.9	Feb. 9, 1884
Cincinnati	43.0	46.3	46.3	45.1	44.6	45.5	41.8	41.5	44.4	49.7	71.1	Feb. 14, 1884

FLOOD OF FEBRUARY 24, 1897.

The flood of February 24, 1897, reached a maximum of 29.5 feet at Pittsburgh. It was caused by a three days' rainfall, which was very light on the up-

per Allegheny, the average for that entire basin amounting to only 0.98 inch as against an average of 2.55 inches on the Monongahela Basin. As a result of this unequal distribution of the rainfall, the Monongahela at Lock No. 4 reached a height of 36.0 feet on the 23rd, within 6 feet of the great flood of 1888, remaining at this stage for 24 hours or more; but the stages of the Allegheny at Parker, Oil City and Warren showed very little increase. The Youghiogheny rose to 22.0 feet at West Newton, its greatest recorded stage, except that of March, 1907, while the Kiskiminetas was but a small contributor to the flood. The Cheat and West Fork of the Monongahela were at high stages, and were important factors in causing the high stage at Lock No. 4.

The following table gives the gage heights at river stations during this flood.

TABLE No. 16.

Daily Gage Heights at River Stations. Flood of February 24, 1897.

Station	Date										Highest recorded stage	
	February											
	18	19	20	21	22	23	24	25	26	27	Stage	Date
Brookville	1.4	1.4	1.4	1.6	1.7	3.4	4.1	3.2	2.8	2.7	14.0	June 1, 1889
Warren	1.6	1.6	1.8	1.8	1.8	2.1	2.5	2.0	1.9	1.7	17.4	Mar. 1865
Oil City	2.5	2.5	2.7	2.9	3.0	3.6	4.8	3.9	3.2	3.0	21.0	Mar. 17, 1865
Parker	3.4	3.4	3.4	3.0	3.0	3.9	5.0	4.5	4.0	4.0	28.0	Mar. 1865
Freeport	6.6	7.5	7.1	6.9	8.2	14.6	14.7	11.0	8.9	7.8	32.7	Feb. 18, 1891
Rowlesburg	3.5	3.0	3.0	3.5	10.0	13.5	7.0	6.0	5.0	4.5	22.0	July 10, 1888
Confluence	4.9	5.7	4.2	5.8	11.6	13.0	9.6	6.8	5.6	4.3	18.6	Mar. 14, 1907
West Newton	4.7	5.4	4.7	4.1	10.0	a 21.9	14.0	7.8	5.5	4.6	28.2	Mar. 14, 1907
Weston	0.1	0.0	0.0	3.0	11.0	15.2	3.7	2 0	1.5	0.3	21.0	Oct. 13, 1890
Fairmont	3.2	2.8	2 3	4.5	15.0	27.8	18.0	9.0	4.0	3.5	37.0	July 10, 1888
Morgantown	9.5	8.9	8.5	8.9	16.0	29.0	23.9	14.7	10.7	9 6	30.0	July 11, 1888
Greensboro	10.1	10.0	9.5	9.2	16 5	33.0	24.5	15.8	12.8	11.4	39.0	July 10, 1888
Lock No. 4	12.3	11.0	10.3	10.0	16.0	36.0	36.0	23.0	14.0	11.9	42.0	July 11, 1888
Pittsburgh	8.3	8.8	8.1	7.6	10.1	24.3	b 28.9	19.0	12.0	9.0	35.5	Mar. 15, 1907
Wheeling	13.2	13.3	13.4	12.6	12.4	19.5	35.3	37.0	27.0	17.3	53.1	Feb. 7, 1884
Parkersburg	15.0	14.2	14 2	15.7	21.8	29.8	34.0	37.5	36.4	29.3	53.9	Feb. 9, 1884
Cincinnati	32.3	30.6	29.1	29.5	41.0	50.4	56.0	59.4	61.1	60.9	71.1	Feb. 14, 1884

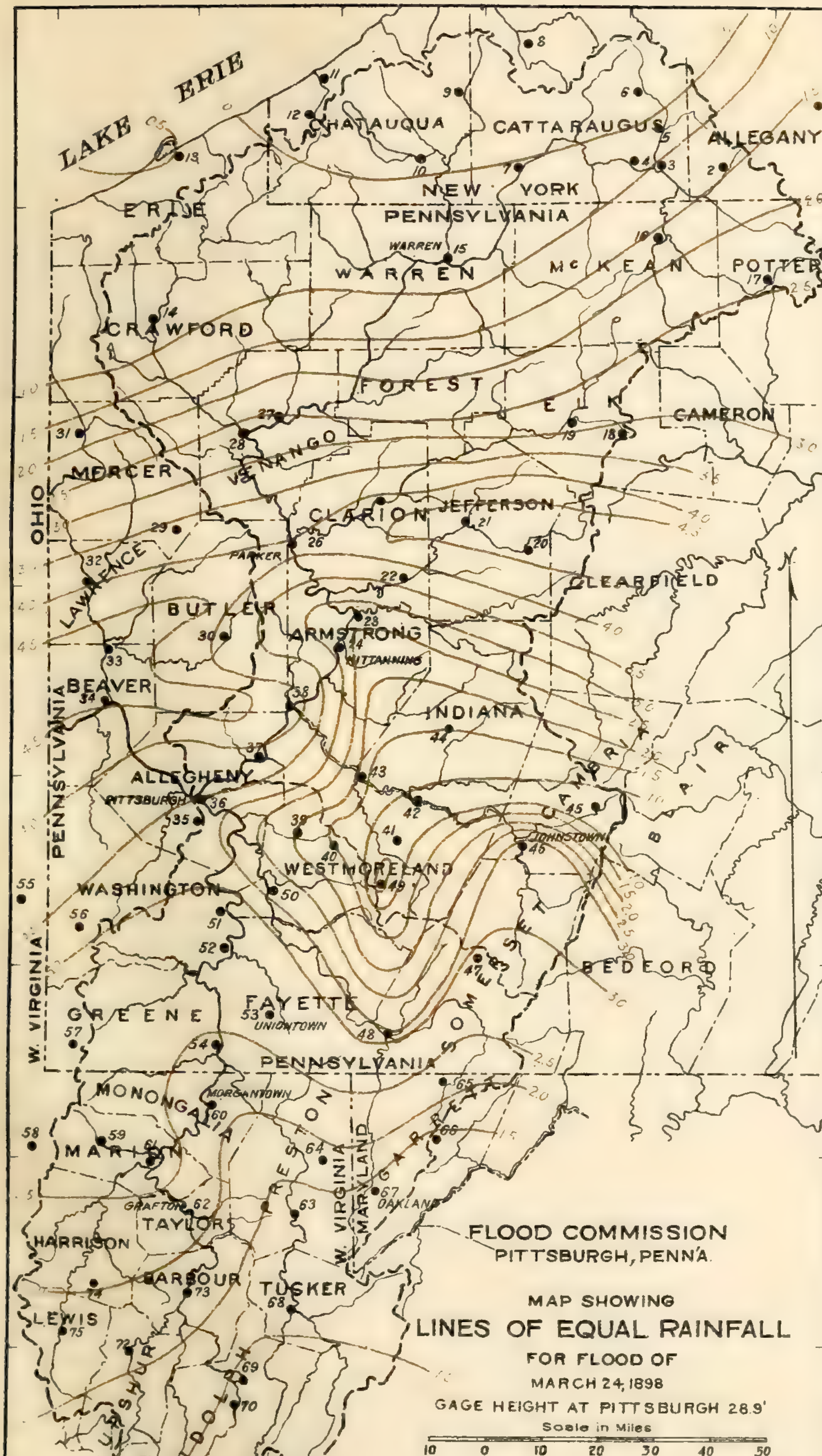
a. Max. 22.0. b. Max. 29.5.

FLOOD OF MARCH 24, 1898.

The flood of March 24, 1898, reached a height of 28.9 feet at 1.00 A. M. and was at or near this stage for about 10 hours. Rain fell practically continuously for the four days, March 20th to 23rd inclusive, the maximum of 5.0 inches occurring at Brookville, Pa., while the headwaters of each of the two main rivers received only about 1.0 inch. No records as to the amount of snow on the ground are available. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 2, shows the total amount and distribution. No attempt has been made to show the rainfall of earlier floods, as the records preceding this time are too incomplete to be satisfactory for this purpose.

The upper portions of the Allegheny and Monongahela Basins were not large contributors to this flood on account of the relatively light rainfall in these sections, while the maximum flow of the Cheat arrived too late at Pittsburgh to be a factor in producing the crest. The Clarion River, and Red Bank and Mahoning Creeks had the greatest run-off, and the simultaneous arrival of their flood crests at Pittsburgh doubtless was largely responsible for the stage reached by this flood.

The following table gives the gage heights at river stations during this flood.



FLOOD COMMISSION
PITTSBURGH, PENN'A.

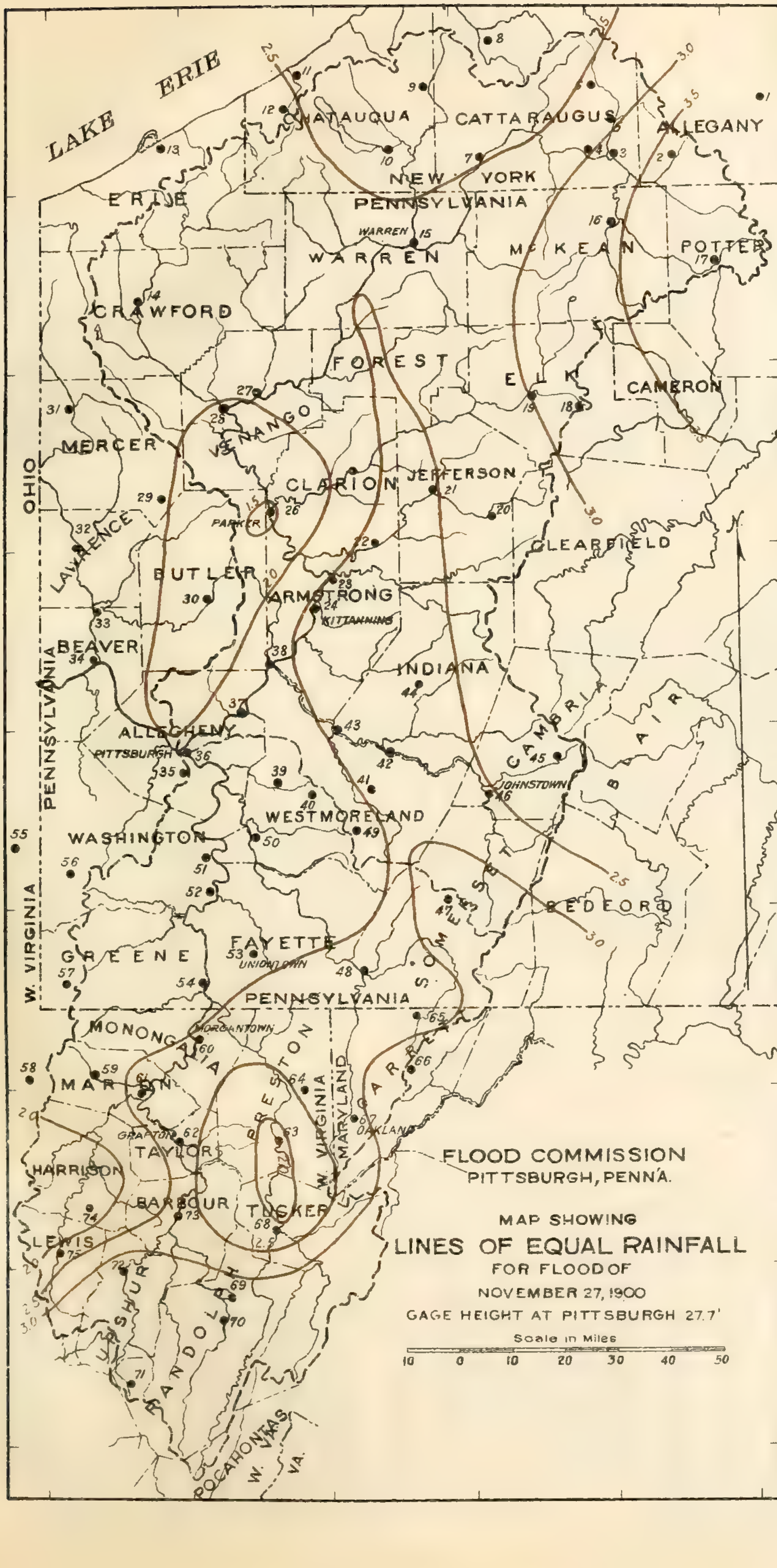
MAP SHOWING
LINES OF EQUAL RAINFALL
FOR FLOOD OF
MARCH 24, 1898
GAGE HEIGHT AT PITTSBURGH 28.9'

Scale in Miles
10 0 10 20 30 40 50

TOTAL RAINFALL INCHES

1	Alfred	N.Y.	1.27
2	Bolivar	" "	1.50
3	Olean	" "	
4	Allegany	" "	
5	Humphrey	" "	.88
6	Franklinville	" "	1.31
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	1.05
11	Westfield	" "	1.28
12	Volusia	" "	
13	Erie	Pa.	.51
14	Saegerstown	"	.59
15	Warren	"	.60
16	Smethport	"	
17	Coudertsport	"	
18	St. Marys	"	
19	Ridgway	"	2.88
20	Dubois	"	
21	Brookville	"	4.99
22	Hawthorn	"	
23	Mahoning	"	3.58
24	Kittanning	"	
25	Clarion	"	4.11
26	Parkers L'nd'g.	"	4.15
27	Oil City	"	2.59
28	Franklin	"	
29	Grove City	"	
30	Butler	"	
31	Greenville	"	
32	Skidmore	"	
33	Elwood J'ct.	"	5.00
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	3.41
37	Springdale	"	
38	Freeport	"	4.47
39	Irwin	"	
40	Greensburg	"	
41	Derry	"	.53
42	Blairsville	"	
43	Saltsburg	"	
44	Indiana	"	
45	Cassandra	"	.59
46	Johnstown	"	3.44
47	Somerset	"	
48	Confluence	"	3.05
49	Lycippus	"	.44
50	West Newton	"	3.01
51	Lock No. 4	"	2.95
52	California	"	
53	Uniontown	"	
54	Greensboro	"	2.39
55	Wellsburg	W. Va.	
56	Claysville	Pa.	
57	Aleppo	"	
58	Smithfield	W. Va.	
59	Mannington	"	
60	Morgantown	"	2.37
61	Fairmont	"	2.71
62	Grafton	"	
63	Rowlesburg	"	1.28
64	Terra Alta	"	
65	Grantsville	Md.	2.26
66	Deer Park	"	1.31
67	Oakland	"	
68	Parsons	W. Va.	
69	Elkins	"	
70	Beverly	"	.98
71	Pickens	"	
72	Buckhannon	"	
73	Phillipi	"	1.84
74	Lost Creek	"	2.05
75	Weston	"	1.76

Above rainfall is for 96 hours previous to 8 A.M. March 23, 1898.



TOTAL RAINFALL		INCHES
1 Alfred	NY	2.18
2 Bolivar	" "	3.81
3 Olean	" "	
4 Allegany	" "	
5 Humphrey	" "	3.00
6 Franklinville	" "	2.55
7 Redhouse	" "	
8 Otto	" "	
9 Cherry Creek	" "	
10 Jamestown	" "	2.11
11 Westfield	" "	
12 Volusia	" "	2.69
13 Erie	Pa.	
14 Saegerstown	"	
15 Warren	"	2.71
16 Smethport	"	
17 Coudertsport	"	
18 St. Marys	"	
19 Ridgway	"	
20 Dubois	"	
21 Brookville	"	2.50
22 Hawthorn	"	
23 Mahoning	"	2.55
24 Kittanning	"	
25 Clarion	"	2.37
26 Parkers L'nd'g.	"	1.45
27 Oil City	"	2.07
28 Franklin	"	
29 Grove City	"	
30 Butler	"	
31 Greenville	"	
32 Skidmore	"	
33 Elwood J'ct.	"	2.20
34 Beaver Dam	"	
35 Baldwin	"	
36 Pittsburgh	"	2.24
37 Springdale	"	
38 Freeport	"	2.42
39 Irwin	"	
40 Greensburg	"	
41 Derry	"	2.55
42 Blairsville	"	
43 Saltsburg	"	
44 Indiana	"	
45 Cassandra	"	
46 Johnstown	"	2.51
47 Somerset	"	3.37
48 Confluence	"	2.71
49 Lycippus	"	1.98
50 West Newton	"	2.25
51 Lock No. 4	"	2.36
52 California	"	
53 Uniontown	"	
54 Greensboro	"	2.33
55 Wellsburg	W. Va.	
56 Claysville	Pa.	
57 Aleppo	"	
58 Smithfield	W. Va	
59 Mannington	"	
60 Morgantown	"	2.51
61 Fairmont	"	2.61
62 Grafton	"	2.70
63 Rowlesburg	"	1.70
64 Terra Alta	"	2.65
65 Grantsville	Md.	2.80
66 Deer Park	"	3.48
67 Oakland	"	
68 Parsons	W. Va.	2.00
69 Elkins	"	3.31
70 Beverly	"	
71 Pickens	"	
72 Buckhannon	"	3.26
73 Phillipi	"	2.57
74 Lost Creek	"	1.49
75 Weston	"	2.40

Above rainfall is for 72 hours previous to 8 A.M. November 26, 1900.

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TABLE No. 17.

Daily Gage Heights at River Stations. Flood of March 24, 1898.

Station	Date: March 18	19	20	21	22	23	24	25	26	27	Highest recorded stage: Stage	Date
Brookville	1.8	1.8	4.5	3.4	3.2	10.5	6.9	3.7	2.9	2.6	14.0	June 1, 1889
Clarion	----	----	----	----	----	a 11.5	----	----	----	----	16.0	Mar. 20, 1905
Warren	3.7	3.5	5.8	6.0	5.5	6.8	7.2	6.2	6.0	5.0	17.4	Mar. 1865
Oil City	3.9	4.1	7.0	7.0	6.5	9.2	10.2	8.5	7.0	6.0	21.0	Mar. 17, 1865
Parker	4.7	4.0	10.0	9.7	8.7	b 13.5	14.0	10.0	8.2	7.1	28.0	Mar. 1865
Freeport	7.5	7.0	10.6	15.9	16.1	c 25.2	25.3	18.9	14.3	11.9	32.7	Feb. 18, 1891
Rowlesburg	7.0	5.4	4.0	6.0	7.0	d 7.2	7.5	8.0	5.0	4.5	22.0	July 10, 1888
Confluence	5.8	4.0	4.0	6.0	7.5	7.6	7.6	8.1	6.8	4.0	18.6	Mar. 14, 1907
West Newton	5.1	4.9	2.7	5.0	10.3	e 10.1	10.9	8.7	7.5	5.4	28.2	Mar. 14, 1907
Weston	3.2	1.0	1.5	3.5	3.0	1.5	4.0	8.0	1.5	0.5	21.0	Oct. 13, 1890
Fairmont	11.0	6.2	4.2	7.3	11.2	7.1	8.4	18.4	10.6	5.4	37.0	July 10, 1888
Greensboro	15.5	13.0	11.0	12.4	16.0	14.0	14.5	21.2	16.0	12.0	39.0	July 10, 1888
Lock No. 4	20.0	16.7	12.7	13.8	22.5	20.7	20.2	24.7	23.8	16.0	42.0	July 11, 1888
Pittsburgh	10.2	11.4	9.3	14.6	19.5	24.9	f 28.5	22.5	20.3	15.0	35.5	Mar. 15, 1907
Wheeling	10.4	14.2	15.3	18.9	25.6	35.4	43.9	42.9	37.0	29.9	53.1	Feb. 7, 1884
Parkersburg	16.5	14.0	16.1	21.2	29.2	32.0	40.0	46.8	47.8	45.2	53.9	Feb. 9, 1884
Cincinnati	23.5	27.1	31.8	38.5	41.9	44.1	49.2	51.8	54.6	57.9	71.1	Feb. 14, 1884

a. Max. as far as records show; only reading during flood.
b. Max. 15.5, 9 P.M.
c. Max. 28.4, 8 P.M.
d. Max. 11.0, 10 P.M.
e. Max. 12.3, 4 P.M.
f. Max. 28.9, 1 A.M.

FLOOD OF NOVEMBER 27, 1900.

The flood of November 27, 1900, reached a height of 27.7 feet at 10.00 A. M. and remained at this point only a very short time, and above the danger mark of 22.0 feet only 34 hours in all. This rise was caused entirely by a rainfall amounting to 2.0 inches or more over the greater part of the two basins and reaching a maximum of 3.81 inches at Bolivar, N. Y., the eastern part of the watershed receiving the greatest precipitation. Both this flood and that of April 21, 1901, were due to a heavy rainfall which would have caused a much higher stage at Pittsburgh had the ground been covered with snow or in the frozen condition that would give the highest rate of run-off. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 3, shows its total amount and distribution.

All the streams were at moderately high stages and contributed to the crest, except the West Fork and upper Tygart Valley Rivers, the flood waters of which arrived too late at Pittsburgh. No particular streams appear to have been especially responsible for the high stage at Pittsburgh.

The following table gives the gage heights at river stations during this flood.

TABLE No. 18.

Daily Gage Heights at River Stations. Flood of November 27, 1900.

Station	Date: November 21	22	23	24	25	26	27	28	29	30	Highest recorded stage: Stage	Date
Brookville	1.2	1.3	1.3	1.0	1.8	6.2	4.2	3.1	2.5	2.3	14.0	June 1, 1889
Clarion	----	----	----	----	2.8	7.9	a10.4	6.7	---	---	16.0	Mar. 20, 1905
Warren	3.2	4.0	3.8	3.8	4.0	8.6	b 9.0	7.9	7.5	8.0	17.4	Mar. 1865
Oil City	3.6	3.8	4.0	3.9	3.9	7.8	10.0	8.6	7.4	7.0	21.0	Mar. 17, 1865
Parker	3.4	4.0	4.1	3.7	4.2	8.7	12.6	10.2	8.8	8.1	28.0	Mar. 1865
Freeport	3.9	6.6	7.1	6.6	6.8	13.0	21.7	17.0	14.1	12.8	32.7	Feb. 18, 1891
Herr Island	6.4	8.3	9.4	8.8	8.5	13.7	28.1	22.9	17.8	15.4	36.9	Mar. 15, 1907
Rowlesburg	2.0	2.0	4.5	5.0	5.0	c 11.0	8.0	4.0	3.0	3.0	22.0	July 10, 1888
Confluence	1.2	1.4	2.4	2.8	3.3	10.3	7.3	5.2	4.1	3.7	18.6	Mar. 14, 1907
West Newton	1.2	2.0	1.7	2.2	2.5	d 7.9	12.1	6.7	4.3	3.3	28.2	Mar. 14, 1907
Weston	1.1	1.5	1.3	1.3	2.5	12.3	4.0	1.2	0.5	0.3	21.0	Oct. 13, 1890
Fairmont	1.0	2.0	2.6	2.6	3.8	e 16.3	19.4	8.4	5.2	3.8	37.0	July 10, 1888
Greensboro	7.8	8.6	9.3	8.9	9.4	f 18.2	22.3	14.6	11.0	9.5	39.0	July 10, 1888
Lock No. 4	8.5	9.8	10.3	10.9	11.2	17.6	33.8	22.6	14.8	11.5	42.0	July 11, 1888
Pittsburgh	5.9	6.7	7.8	6.8	7.0	11.8	g27.3	21.4	15.3	12.1	35.5	Mar. 15, 1907
Wheeling	2.9	3.6	7.0	9.0	9.9	10.3	19.3	34.3	28.2	21.0	53.1	Feb. 7, 1884
Parkersburg	4.0	4.4	4.9	7.0	9.2	11.5	15.8	25.2	30.0	27.0	53.9	Feb. 9, 1884
Cincinnati	8.0	10.4	8.6	9.6	14.9	18.0	23.0	32.5	37.9	h 39.0	71.1	Feb. 14, 1884

a. Max. as far as records show; gage read only for four days.
b. Max. 9.5, 6 P.M.
c. Max. 11.0, 5 A.M.
d. Max. 14.7, 6 P.M.
e. Max. 23.9, 6 P.M.
f. Max. 27.4, 6 P.M.
g. Max. 27.7, 10 A.M.
h. Max. 40.0, Dec. 1.

FLOOD OF APRIL 21, 1901.

The flood of April 21, 1901, reached a height of 27.5 feet at 3 A. M. and remained practically at this height for 15 hours. The rise was caused entirely by a heavy rain which fell on the 19th, 20th and 21st, during which time the entire Allegheny Basin received a precipitation of from 2 to 4 inches, while the rainfall on the Monongahela Basin varied from 4 inches, in the northwestern part, to 0.10 inch at Parsons, in the southeastern section. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 4, shows its total amount and distribution.

All the streams, with a few exceptions, were flowing fairly full during this flood, but none approached their maximum recorded stages. The Cheat and Youghiogheny were relatively unimportant factors in the rise, as their basins received the lightest precipitation. The upper Allegheny crest did not reach Pittsburgh until the crest at that point had nearly passed, as the maximum stage at Oil City did not occur until the 22nd. This was also the case with the Cheat River, the maximum stage of 8.0 feet at Rowlesburg not being reached until 8.00 A. M. on the 21st.

The following table gives the gage heights at river stations during this flood.

TABLE No. 19.

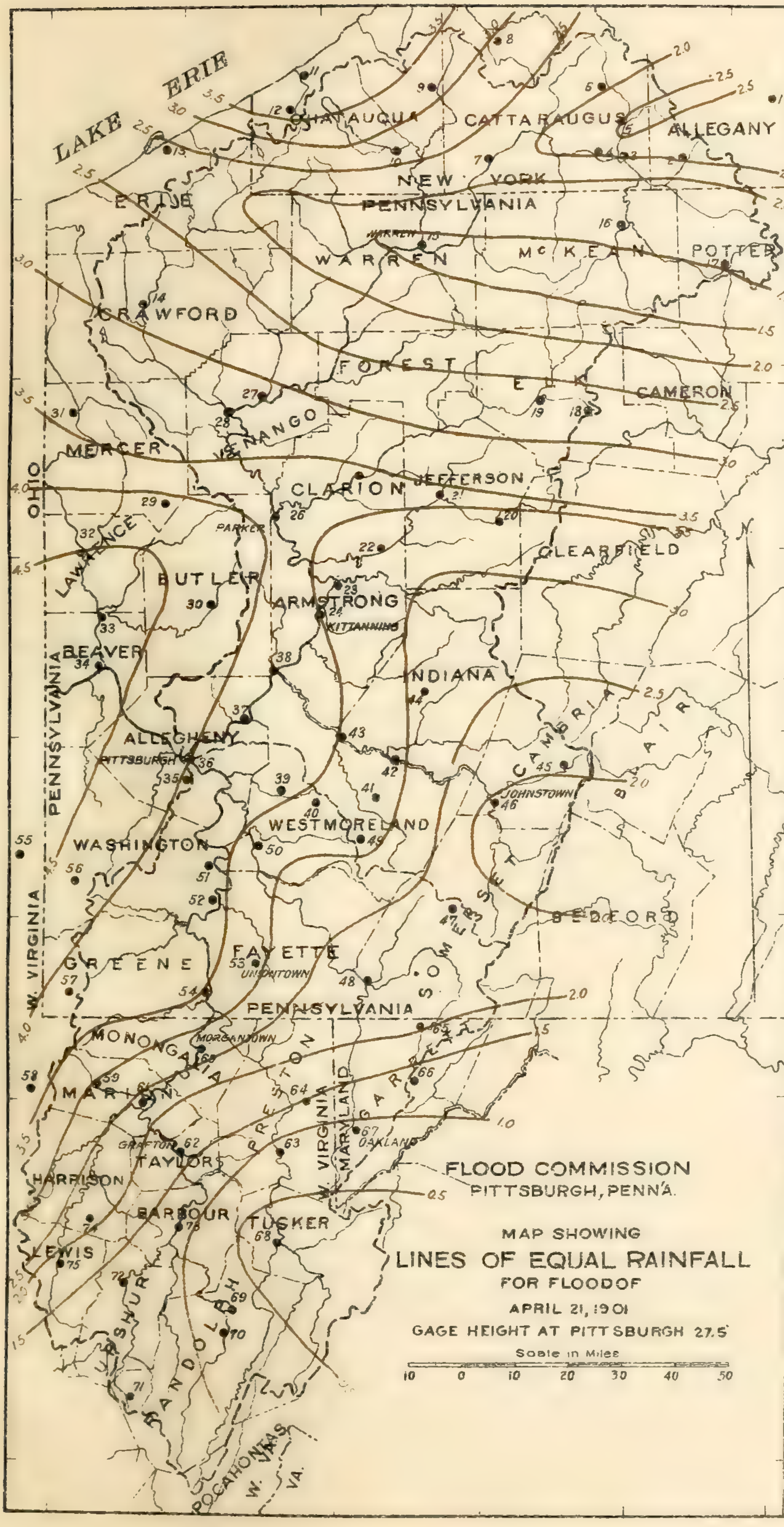
Daily Gage Heights at River Stations. Flood of April 21, 1901.

Station	Date										Highest recorded stage	
	April											
	15	16	17	18	19	20	21	22	23	24	Stage	Date
Brookville	1.6	1.6	1.6	1.6	2.2	5.7	4.2	3.8	2.6	2.2	14.0	June 1, 1889
Warren	4.6	4.2	4.0	3.5	3.2	4.2	6.9	9.5	10.0	10.0	17.4	Mar. 1865
Oil City	4.4	4.2	4.0	3.8	3.7	7.1	9.5	11.0	10.5	10.4	21.0	Mar. 17, 1865
Parker	5.0	4.6	4.2	3.9	3.9	a 9.9	12.0	12.0	12.0	11.4	28.0	Mar. 1865
Freeport	9.1	8.8	8.0	7.0	6.9	16.0	13.0	19.4	18.3	17.0	32.7	Feb. 18, 1891
Herr Island	11.0	12.2	11.3	9.8	9.5	19.2	28.6	24.3	21.3	19.9	36.9	Mar. 15, 1907
Rowlesburg	6.0	5.0	4.5	4.3	4.0	6.0	b 8.0	7.5	7.0	6.5	22.0	July 10, 1888
Confluence	3.0	2.8	2.7	2.6	3.0	4.6	8.5	6.9	5.5	5.0	18.6	Mar. 14, 1907
West Newton	3.3	3.7	3.7	3.2	3.0	9.2	12.0	10.3	7.5	6.1	28.2	Mar. 14, 1907
Weston	4.4	1.7	1.0	0.6	0.4	4.5	5.0	2.9	3.2	1.7	21.0	Oct. 13, 1890
Fairmont	10.8	9.1	6.5	4.6	3.2	13.0	10.2	9.8	7.2	6.4	37.0	July 10, 1888
Greensboro	12.1	12.5	11.7	10.8	10.5	17.3	16.8	15.0	13.0	12.2	39.0	July 10, 1888
Lock No. 4	10.9	17.0	15.6	12.6	12.0	c 23.3	25.5	21.5	17.2	15.0	42.0	July 11, 1888
Pittsburgh	8.5	11.0	10.2	8.5	8.0	17.4	d27.4	23.0	19.5	17.0	35.5	Mar. 15, 1907
Wheeling	11.8	12.6	14.3	13.6	12.9	23.8	37.0	41.3	37.0	32.2	53.1	Feb. 7, 1884
Parkersburg	12 0	12.9	13.0	14.0	14.6	27.8	37.0	41.0	e 43.0	43.7	53.9	Feb. 9, 1884
Cincinnati	28.9	25.8	23.9	24.8	26.3	31.1	40.7	47.9	53.2	f 56.4	71.1	Feb. 14, 1884

a. Max. 12.7.
b. Max. 8.0, 8 A.M.
c. Max. 26.5.
d. Max. 27.5, 3 A.M. and 6 P.M.
e. Max. 43.9, 7 P.M.
f. Max. 59.7, April 27.

FLOOD OF MARCH 1, 1902.

The flood of March 1, 1902, reached a height of 32.4 feet at 6.00 P. M., and remained at this height for about two hours. This was the first time in eleven years that the water had reached the 30-foot mark. The rainfall, which was unusually light for so great a flood, was practically concentrated into one day, February 28, and this, combined with the run-off of a large amount of melted snow, was the reason for the magnitude of the rise. The upper Youghiogheny received the greatest rainfall, the maximum of 2.45 inches being recorded at Somerset, Pa. This flood affords a striking example of what may result from a general rainfall of no very great intensity, when combined with proper conditions of melting snow and frozen ground. The precipitation causing the floods of April 21, 1901, and November 27, 1900, was much heavier than the rainfall preceding this flood, but there was no snow on the ground,



TOTAL RAINFALL			INCHES
1	Alfred	N.Y.	2.75
2	Bolivar	" "	2.07
3	Olean	" "	
4	Allegany	" "	
5	Humphrey	" "	2.53
6	Franklinville	" "	1.98
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	2.69
11	Westfield	" "	
12	Volusia	" "	3.71
13	Erie	Pa.	2.13
14	Saegerstown	"	2.78
15	Warren	"	1.35
16	Smethport	"	
17	Coudertsport	"	
18	St. Marys	"	
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	3.56
22	Hawthorn	"	3.07
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	
26	Parkers L'nd'g.	"	3.95
27	Oil City	"	3.18
28	Franklin	"	3.22
29	Grove City	"	
30	Butler	"	
31	Greenville	"	
32	Skidmore	"	
33	Elwood J'ct.	"	4.90
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	4.00
37	Springdale	"	
38	Freeport	"	3.84
39	Irwin	"	
40	Greensburg	"	
41	Derry	"	3.39
42	Blairsville	"	
43	Saltsburg	"	
44	Indiana	"	
45	Cassandra	"	2.20
46	Johnstown	"	1.70
47	Somerset	"	2.33
48	Confluence	"	2.06
49	Lycippus	"	3.28
50	West Newton	"	3.40
51	Lock No. 4	"	
52	California	"	
53	Uniontown	"	
54	Greensboro	"	3.55
55	Wellsburg	W.Va.	4.88
56	Claysville	Pa.	
57	Aleppo	"	
58	Smithfield	W.Va.	
59	Mannington	"	3.00
60	Morgantown	"	2.66
61	Fairmont	"	2.41
62	Grafton	"	
63	Rowlesburg	"	.86
64	Terra Alta	"	
65	Grantsville	Md.	2.14
66	Deer Park	"	1.37
67	Oakland	"	
68	Parsons	W.Va.	.10
69	Elkins	"	.92
70	Beverly	"	.90
71	Pickens	"	
72	Buckhannon	"	1.18
73	Phillipi	"	1.27
74	Lost Creek	"	2.20
75	Weston	"	1.86

Above rainfall is for 72 hours previous to 8 A.M. April 21, 1901.

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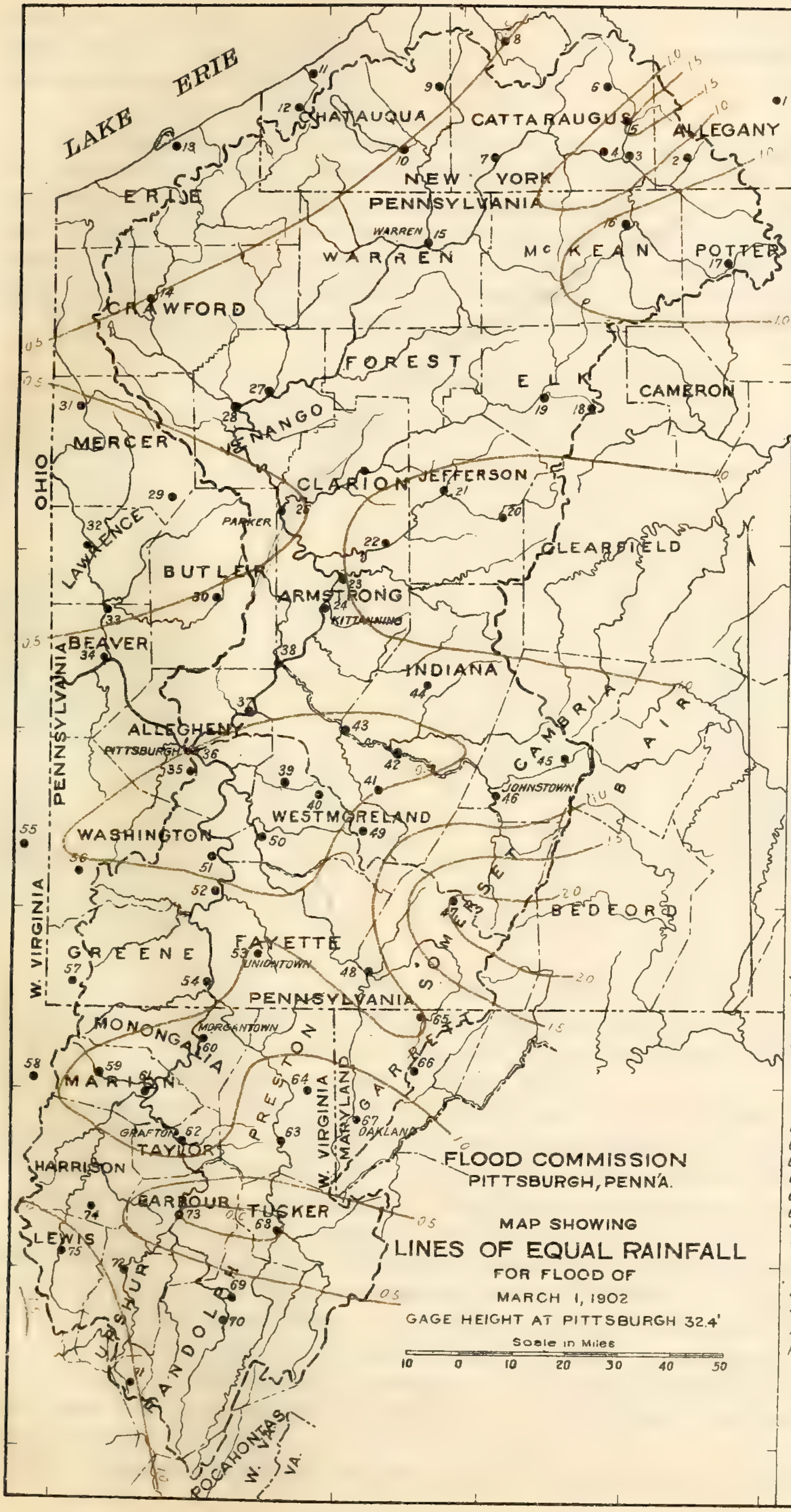

FLOOD COMMISSION
PITTSBURGH, PENN'A.

MAP SHOWING
LINES OF EQUAL RAINFALL
FOR FLOOD OF
MARCH 1, 1902
GAGE HEIGHT AT PITTSBURGH 32.4'

Scale in Miles
10 0 10 20 30 40 50

TOTAL RAINFALL			INCHES
1	Alfred	N.Y.	
2	Bolivar	" "	.74
3	Olean	" "	
4	Allegany	" "	
5	Humphrey	" "	1.54
6	Franklinville	" "	.80
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	.55
11	Westfield	" "	
12	Volusia	" "	.26
13	Erie	Pa.	.11
14	Saegerstown	"	.50
15	Warren	"	.62
16	Smethport	"	1.20
17	Coudertsport	"	
18	St. Marys	"	.80
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	1.35
22	Hawthorn	"	1.48
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	.80
26	Parkers L'nd'g.	"	.39
27	Oil City	"	.51
28	Franklin	"	.79
29	Grove City	"	
30	Butler	"	
31	Greenville	"	
32	Skidmore	"	
33	Elwood J'ct.	"	.52
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	.48
37	Springdale	"	
38	Freeport	"	.36
39	Irwin	"	.37
40	Greensburg	"	
41	Derry	"	.58
42	Blairsville	"	
43	Saltsburg	"	.42
44	Indiana	"	
45	Cassandra	"	.69
46	Johnstown	"	.76
47	Somerset	"	2.05
48	Confluence	"	.72
49	Lycippus	"	.54
50	West Newton	"	.36
51	Lock No. 4	"	.38
52	California	"	.57
53	Uniontown	"	1.12
54	Greensboro	"	.73
55	Wellsburg	W. Va.	.52
56	Claysville	Pa.	
57	Aleppo	"	.52
58	Smithfield	W. Va.	
59	Mannington	"	1.10
60	Morgantown	"	1.23
61	Fairmont	"	1.35
62	Grafton	"	1.38
63	Rowlesburg	"	.71
64	Terra Alta	"	.80
65	Grantsville	Md.	.95
66	Deer Park	"	1.10
67	Oakland	"	
68	Parsons	W. Va.	.00
69	Elkins	"	.62
70	Beverly	"	
71	Pickens	"	
72	Buckhannon	"	.85
73	Phillipi	"	.00
74	Lost Creek	"	.88
75	Weston	"	1.17

Above rainfall is for 72 hours previous to 8 A.M. February 28, 1902.

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nor was it in the frozen condition necessary for a high rate of run-off, so that the crests of the 1901 and 1900 floods were only 27.5 and 27.7 feet respectively. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 5, shows its total amount and distribution.

The Youghiogheny was a large contributor to this flood, and its stage of 22.0 feet at West Newton equals the highest recorded except that of 28.2 feet in March, 1907. The Clarion came within 2 feet of maximum stage, but its greatest flow arrived at Pittsburgh after flood peak time. The Allegheny at Freeport came within 2.7 feet of record stage, while the Monongahela at Lock No. 4 reached a stage 12.0 feet below the maximum of 1888, and its flood crest arrived at Pittsburgh after the highest stage had passed.

The following table gives the gage heights at river stations during this flood.

TABLE No. 20.

Daily Gage Heights at River Stations. Flood of March 1, 1902.

Station	Date										Highest recorded stage	
	February						March					
	23	24	25	26	27	28	1	2	3	4	Stage	Date
Brookville	1.0	1.0	1.0	1.0	1.0	4.2	6.7	4.8	3.6	2.5	14.0	June 1, 1889
Clarion	2.5	2.5	2.2	2.6	3.2	7.0	14.0	10.6	8.0	6.0	16.0	Mar. 20, 1905
Saltsburg	0.6	0.6	.1.8	2.2	4.0	7.0	15.5	7.5	6.0	3.8	22.1	1859
Warren	0.9	1.0	1.3	1.4	1.5	5.8	12.5	13.5	13.0	11.0	17.4	Mar. 1865
Oil City	3.3	3.1	3.1	3.2	3.5	5.4	14.5	15.3	14.2	12.5	21.0	Mar. 17, 1865
Parker	1.3	1.3	1.4	1.5	1.8	5.1	a18.0	18.0	12.5	11.5	28.0	Mar. 1865
Freeport	4.5	4.5	5.1	5.4	11.0	12.9	b28.8	26.8	23.9	19.7	32.7	Feb. 18, 1891
Herr Island	2.6	3.5	5.7	7.1	11.8	13.6	31.0	33.7	27.1	22.0	36.9	Mar. 15, 1907
Rowlesburg	F	F	F	6.0	5.0	c 7.0	10.0	7.0	6.0	5.0	22.0	July 10, 1888
Confluence	1.5	1.5	1.6	3.3	4.0	10.1	9.9	7.5	6.0	4.3	18.6	Mar. 14, 1907
West Newton	F	F	F	F	F	22.0	21.0	13.5	11.5	7.3	28.2	Mar. 14, 1907
Weston	0.2	2.3	4.3	5.7	2.2	4.1	3.5	1.2	2.0	0.9	21.0	Oct. 13, 1890
Fairmont	1.5	6.0	8.8	15.0	12.6	9.7	15.0	9.4	7.2	5.1	37.0	July 10, 1888
Greensboro	6.8	8.3	10.6	16.2	15.5	15.5	22.7	15.8	14.2	12.1	39.0	July 10, 1888
Lock No. 4	7.3	9.5	11.6	16.4	21.5	18.8	d29.5	25.1	20.0	15.6	42.0	July 11, 1888
Pittsburgh	2.0	2.9	5.3	6.9	12.0	13.1	e 29.3	30.3	25.0	19.9	35.5	Mar. 15, 1907
Wheeling	9.6	9.4	7.4	10.7	12.0	17.7	28.8	42.0	42.0	37.9	53.1	Feb. 7, 1884
Parkersburg	----	4.5	8.0	3.4	16.5	17.0	26.5	32.6	38.2	40.0	53.9	Feb. 9, 1884
Cincinnati	8.4	8.6	11.0	14.1	22.5	33.8	39.6	44.8	48.6	50.4	71.1	Feb. 14, 1884

a. Max. 19.5, 7 P.M.
b. Max. 30.0, 3 P.M.
c. Max. 12.0, 6 P.M.
d. Max. 30.0, 1 P.M.
e. Max. 32.4, 6 P.M.
F. Frozen.

FLOOD OF MARCH 1, 1903.

The flood of March 1, 1903, reached a height of 28.9 feet at Pittsburgh at 3.00 P. M., and remained at that height for about three hours, when it lowered gradually, registering 25.5 feet at 8 A. M. the following day.

The rain causing this flood fell on the 27th and 28th of February, and was comparatively light over the entire basin, not exceeding 2.0 inches at any point, and in general varying between 1.0 inch and 1.5 inches. The weather, however, was generally cold preceding the rise, and the increase in temperature accompanying the precipitation at the end of February caused a high rate of run-off of rain and melted snow from the frozen ground. Many of the streams were frozen preceding this flood and the ice came out on the night of the 27th. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 6, shows its total amount and distribution.

None of the streams approached previous maximum stages during this flood and none are notable as particularly responsible. The Cheat and the Clarion reached fairly high stages, but their maximum contribution to the Pittsburgh flood arrived after the crest had passed the city.

The following table gives the gage heights at river stations during this flood.

TABLE No. 21.

Daily Gage Heights at River Stations. Flood of March 1, 1903.

Station	Date										Highest recorded stage	
	February						March					
	23	24	25	26	27	28	1	2	3	4	Stage	Date
Brookville	1.6	1.6	1.6	1.6	1.6	3.6	3.8	3.2	2.2	1.5	14.0	June 1, 1889
Clarion	6.8	7.4	7.3	7.0	6.7	9.5	a11.3	7.0	5.5	4.5	16.0	Mar. 20, 1905
Saltsburg	F	F	F	F	F	7.0	8.0	4.5	3.4	2.6	22.1	1859
Warren	F	F	F	F	F	4.7	9.8	8.1	7.0	6.6	17.4	Mar. 1865
Oil City	3.2	3.2	3.2	3.2	3.0	4.0	12.9	11.1	7.9	7.0	21.0	Mar. 17, 1865
Parker	F	F	F	F	F	13.0	15.0	11.4	10.0	8.1	28.0	Mar. 1865
Freeport	3.8	3.8	4.0	4.0	3.9	9.0	23.0	20.3	15.2	13.1	32.7	Feb. 18, 1891
Herr Island	5.9	6.2	6.3	6.1	5.9	8.8	28.6	26.7	19.4	15.0	36.9	Mar. 15, 1907
Rowlesburg	F	F	F	F	F	b 7.0	8.7	5.0	4.2	3.4	22.0	July 10, 1888
Confluence	2.9	2.6	2.6	2.6	2.6	4.6	5.0	4.0	3.8	3.8	18.6	Mar. 14, 1907
West Newton	F	F	F	F	F	c 11.0	15.4	8.7	5.7	4.5	28.2	Mar. 14, 1907
Weston	F	F	F	F	4.0	d 12.8	6.0	5.4	5.0	4.5	21.0	Oct. 13, 1890
Fairmont	4.5	4.5	4.5	4.5	4.5	e 15.5	19.5	10.8	5.7	4.0	37.0	July 10, 1888
Greensboro	8.3	8.3	8.3	8.4	8.6	15.5	24.7	15.3	11.6	10.1	39.0	July 10, 1888
Lock No. 4	9.2	9.0	9.2	9.4	9.5	14.6	32.5	24.6	15.7	12.3	42.0	July 11, 1888
Pittsburgh	5.0	5.1	5.2	5.2	4.9	7.9	f 27.5	25.5	17.5	13.0	35.5	Mar. 15, 1907
Wheeling	9.0	8.9	7.8	8.9	8.9	13.0	28.6	g 39.7	37.3	27.9	53.1	Feb. 7, 1884
Parkersburg	10.7	11.0	11.0	10.7	10.0	18.0	30.0	36.0	h 39.4	38.0	53.9	Feb. 9, 1884
Cincinnati	38.5	32.9	29.8	26.5	25.2	31.4	38.0	44.4	49.0	j 51.6	71.1	Feb. 14, 1884

a. Max. 11.5, 6 P.M.
b. Max. 10.4, 6 P.M.
c. Max. 16.9, 8 P.M.
d. Max. 14.0.
e. Max. 23.8.
f. Max. 28.9, 3 to 6 P.M.
g. Max. 40.2.
h. Max. 39.9.
j. Max. 53.2, Mar. 5.
F. Frozen.

FLOOD OF JANUARY 23, 1904.

The flood of January 23, 1904, reached its maximum of 30.0 feet at 3 P. M., where it remained for about 4 hours. Preceding this rise, the temperature was generally low and the precipitation light, so that the streams were at fairly low stages, and many were frozen over.

The precipitation was light on the entire West Virginia part of the drainage area, and heaviest in the northern part of the Allegheny Basin, French, Oil and Red Bank Creeks receiving the greatest rainfall. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 7, shows its total amount and distribution.

The Clarion River and French Creek were large factors in this flood, while the Youghiogheny at West Newton reached its previous maximum of 22.0 feet, 6.2 feet below the height of the 1907 flood. The maximum flow of the Monongahela above Lock No. 4 arived too late to contribute largely to the Pittsburgh peak.

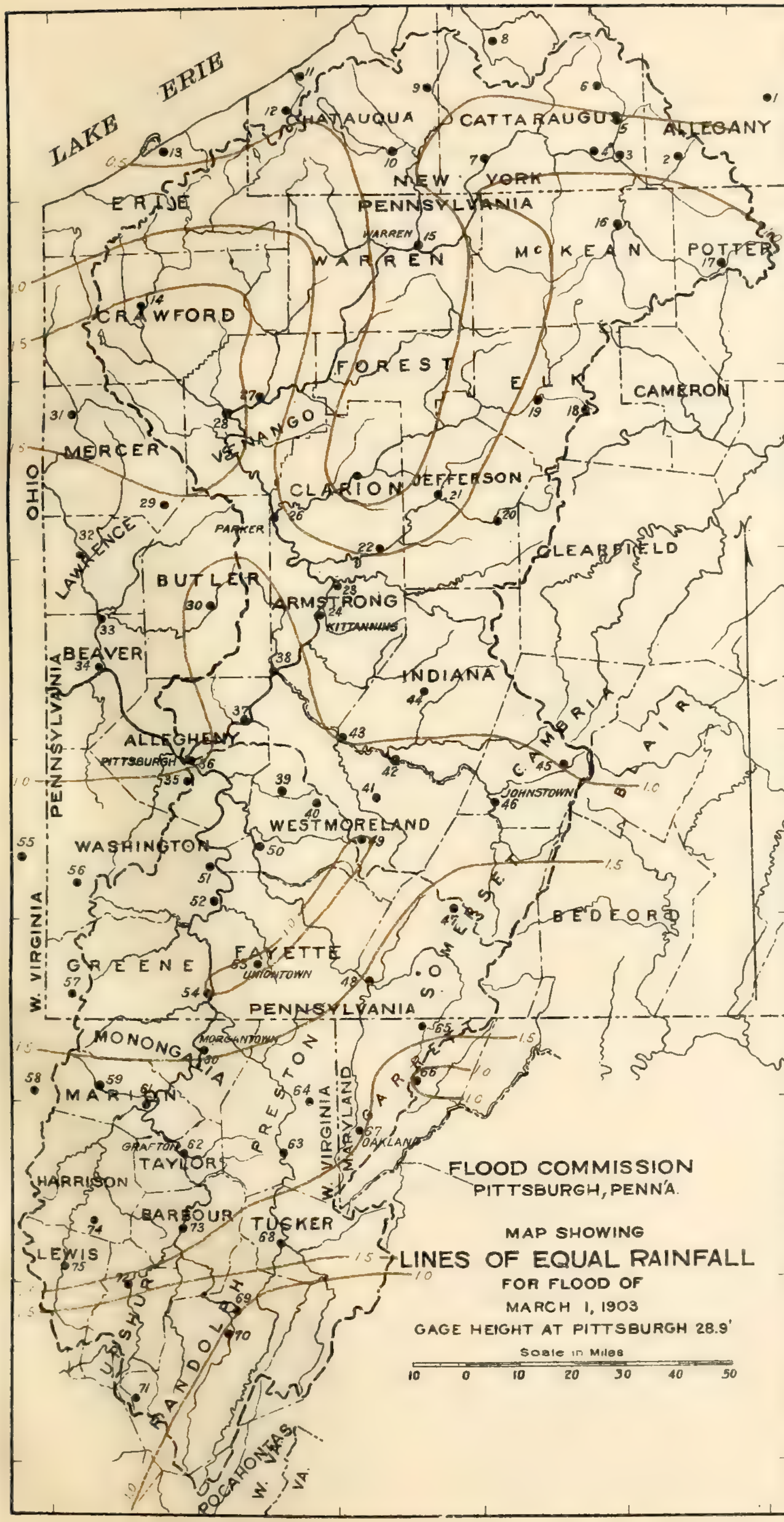
The following table gives the gage heights at river stations during this flood.

TABLE No. 22.

Daily Gage Heights at River Stations. Flood of January 23, 1904.

Station	Date										Highest recorded stage	
	January											
	17	18	19	20	21	22	23	24	25	26	Stage	Date
Brookville	0.2	0.2	0.2	0.2	0.4	5.8	6.0	4.4	2.8	2.0	14.0	June 1, 1889
Clarion	1.3	1.2	1.0	1.0	1.5	6.1	12.5	8.5	6.0	5.0	16.0	Mar. 20, 1905
Saltsburg	F	F	F	F	F	a 9.0	12.0	5.5	3.5	3.0	22.1	1859
Warren	F	F	F	F	F	3.0	10.2	9.0	8.0	6.9	17.4	Mar. 1865
Oil City	3.7	3.7	3.7	3.7	3.8	8.1	13.8	11.6	9.6	7.8	21.0	Mar. 17, 1865
Parker	1.8	1.8	1.8	1.8	2.0	10.0	19.0	14.5	11.0	10.0	28.0	Mar. 1865
Freeport	4.9	4.9	4.8	4.8	4.9	b 21.0	30.7	24.9	18.5	14.8	32.7	Feb. 18, 1891
Herr Island	2.5	2.8	2.7	3.3	4.5	9.4	30.9	29.0	20.9	15.7	36.9	Mar. 15, 1907
Rowlesburg	F	F	F	F	F	6.0	7.8	5.0	4.3	3.8	22.0	July 10, 1888
Confluence	F	F	F	F	F	c 9.0	10.6	5.0	4.2	3.6	18.6	Mar. 14, 1907
West Newton	F	F	F	F	F	d 18.0	16.5	10.0	7.0	5.2	28.2	Mar. 14, 1907
Weston	1.7	1.4	1.3	1.4	1.7	1.7	1.1	0.9	0.7	0.6	21.0	Oct. 13, 1890
Fairmont	15.3	16.0	16.3	16.0	16.2	17.3	19.7	19.4	17.1	16.1	37.0	July 10, 1888
Greensboro	7.4	8.1	8.1	8.0	8.3	e 12.5	15.8	14.4	11.2	9.7	39.0	July 10, 1888
Lock No. 4	6.9	7.1	8.7	9.0	8.8	13.8	21.2	20.0	14.5	11.4	42.0	July 11, 1888
Pittsburgh	1.9	1.9	2.2	2.9	4.0	8.9	f 28.7	27.5	19.2	13.7	35.5	Mar. 15, 1907
Wheeling	10.1	10.1	9.7	9.6	11.1	20.6	34.2	43.9	41.0	31.5	53.1	Feb. 7, 1884
Parkersburg	6.1	6.0	6.0	6.0	6.0	8.8	26.5	35.2	41.4	g 42.0	53.9	Feb. 9, 1884
Cincinnati	13.2	13.6	13.4	13.0	15.2	23.7	22.5	20.3	26.9	h 36.0	71.1	Feb. 14, 1884

a. Max. 12.8, 6 P.M.
b. Max. 31.2, 12 Midnight.
c. Max. 11.6, 3 P.M.
d. Max. 22.0, 12 Noon.
e. Max. 16.4, 6 P.M.
f. Max. 30.0, 3 to 7 P.M.
F. Frozen.
g. Max. 42.4, 12 Midnight.
h. Max. 43.9, Jan. 28.



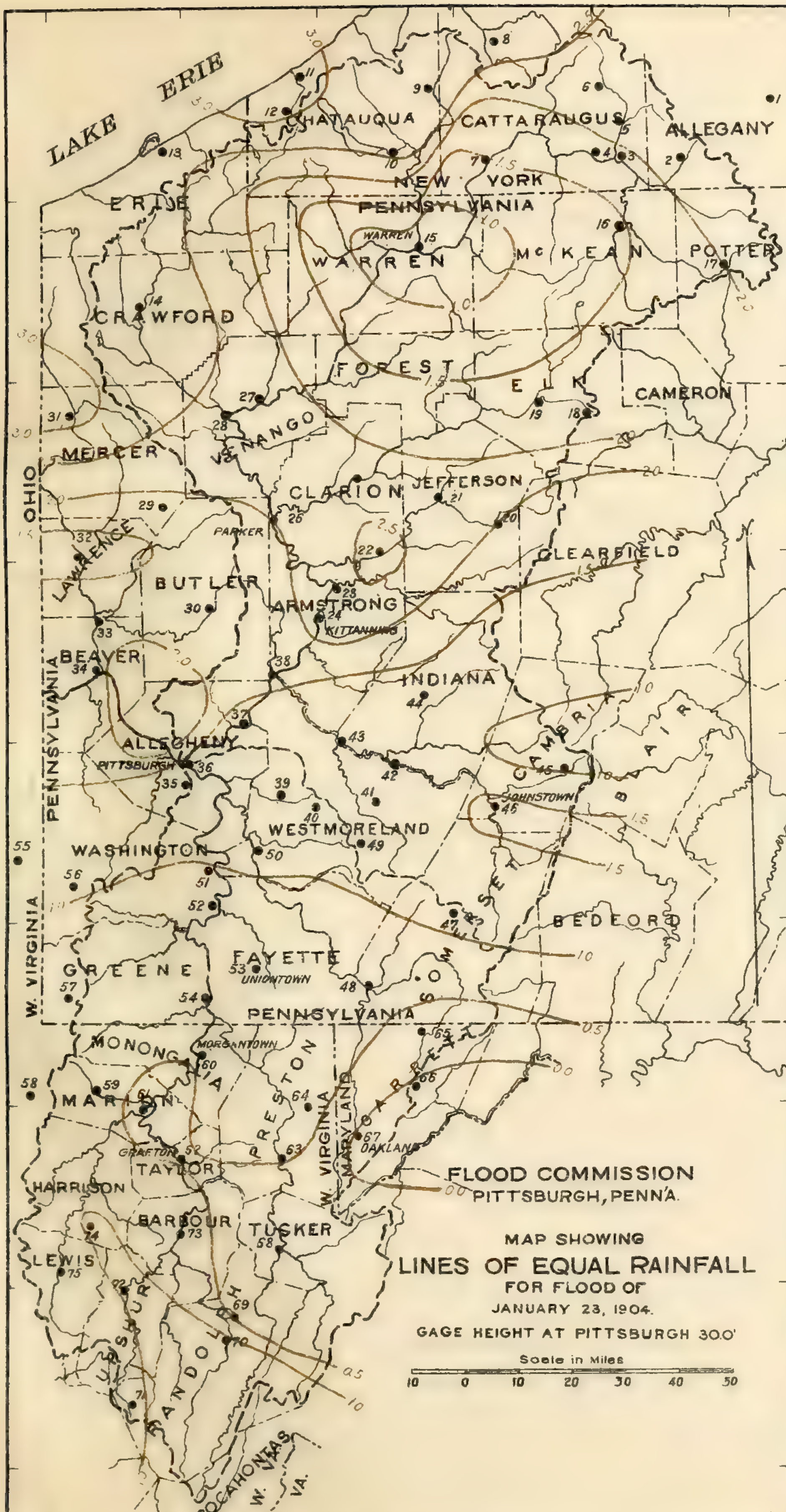
FLOOD COMMISSION
PITTSBURGH, PENN'A.

MAP SHOWING
LINES OF EQUAL RAINFALL
FOR FLOOD OF
MARCH 1, 1903
GAGE HEIGHT AT PITTSBURGH 28.9'

TOTAL RAINFALL			INCHES
1	Alfred	N.Y.	
2	Bolivar	" "	.77
3	Olean	" "	
4	Allegany	" "	
5	Humphrey	" "	
6	Franklinville	" "	.25
7	Redhouse	" "	
8	Otto	" "	.29
9	Cherry Creek	" "	
10	Jamestown	" "	.67
11	Westfield	" "	
12	Volusia	" "	.44
13	Erie	Pa.	.45
14	Saegerstown	"	1.55
15	Warren	"	.24
16	Smethport	"	1.50
17	Coudertsport	"	
18	St. Marys	"	
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	.92
22	Hawthorn	"	
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	.10
26	Parkers L'nd'g.	"	1.10
27	Oil City	"	1.30
28	Franklin	"	1.81
29	Grove City	"	
30	Butler	"	.91
31	Greenville	"	1.62
32	Skidmore	"	
33	Elwood J'ct.	"	1.20
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	.91
37	Springdale	"	
38	Freeport	"	1.29
39	Irwin	"	
40	Greensburg	"	
41	Derry	"	1.44
42	Blairsville	"	
43	Saltsburg	"	.96
44	Indiana	"	.80
45	Cassandra	"	.98
46	Johnstown	"	1.34
47	Somerset	"	1.68
48	Confluence	"	
49	Lycippus	"	1.05
50	West Newton	"	1.24
51	Lock No. 4	"	
52	California	"	1.49
53	Uniontown	"	1.02
54	Greensboro	"	1.00
55	Wellsburg	W.Va	
56	Claysville	Pa.	
57	Aleppo	"	1.31
58	Smithfield	W.Va.	
59	Mannington	"	
60	Morgantown	"	1.43
61	Fairmont	"	1.18
62	Grafton	"	1.17
63	Rowlesburg	"	1.10
64	Terra Alta	"	2.00
65	Grantsville	Md.	1.96
66	Deer Park	"	.91
67	Oakland	"	
68	Parsons	W.Va.	2.00
69	Elkins	"	1.00
70	Beverly	"	1.02
71	Pickens	"	1.30
72	Buckhannon	"	1.53
73	Phillipi	"	1.37
74	Lost Creek	"	2.05
75	Weston	"	1.32

Above rainfall is for 48 hours previous to 8 A.M February 28, 1903.

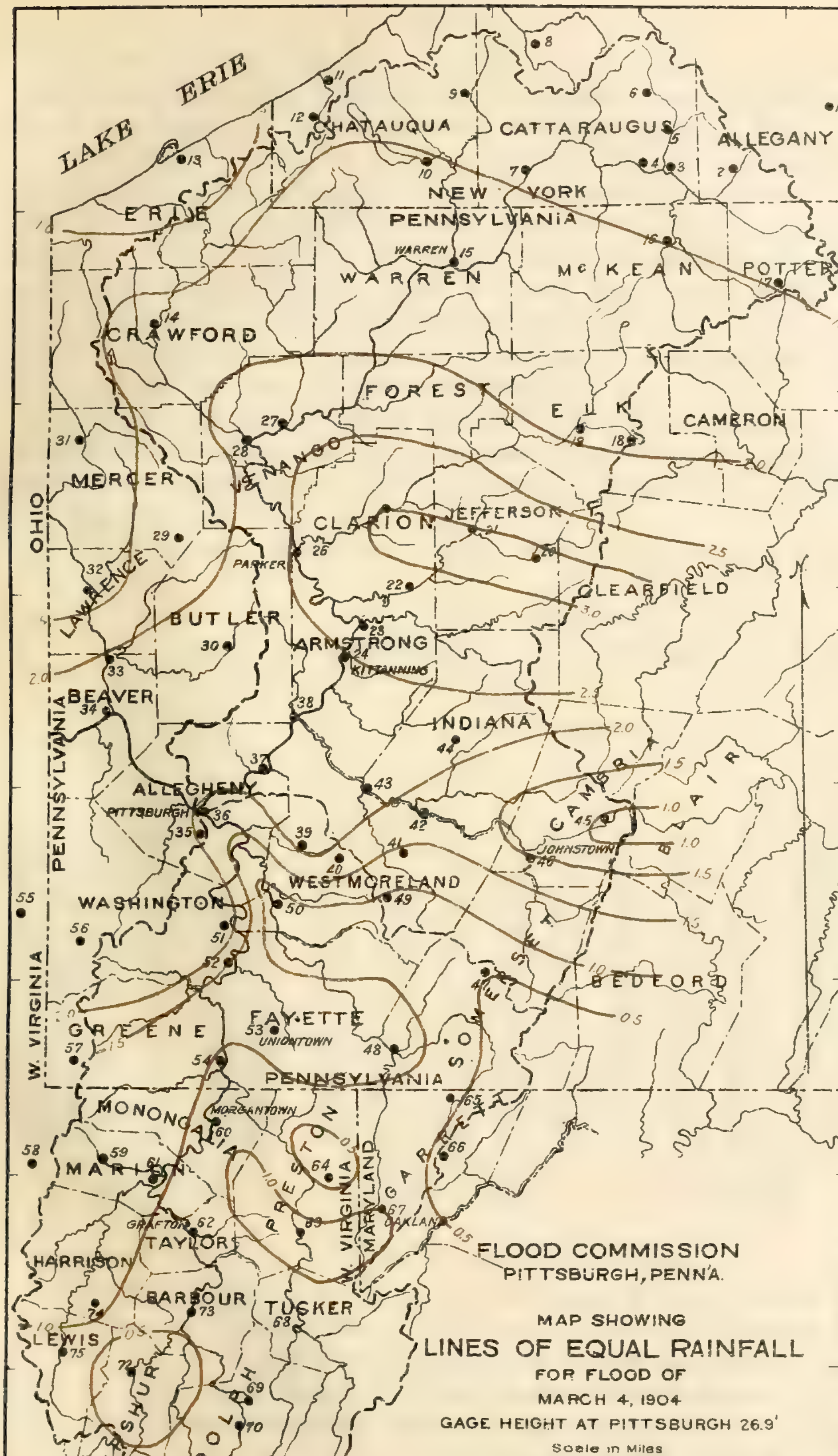
THE LORD BALTO PRESS, BALTO MD.



TOTAL RAINFALL		INCHES
1 Alfred	N.Y.	
2 Bolivar	" "	2.02
3 Olean	" "	
4 Allegany	" "	
5 Humphrey	" "	
6 Franklinville	" "	2.43
7 Redhouse	" "	
8 Otto	" "	2.64
9 Cherry Creek	" "	
10 Jamestown	" "	2.6
11 Westfield	" "	
12 Volusia	" "	3.03
13 Erie	Pa.	2.79
14 Saegerstown	"	2.68
15 Warren	"	.56
16 Smethport	"	
17 Coudertsport	"	
18 St. Marys	"	1.80
19 Ridgway	"	
20 Dubois	"	
21 Brookville	"	2.20
22 Hawthorn	"	2.65
23 Mahoning	"	
24 Kittanning	"	
25 Clarion	"	2.18
26 Parkers L'nd'g.	"	2.00
27 Oil City	"	2.44
28 Franklin	"	2.22
29 Grove City	"	
30 Butler	"	
31 Greenville	"	3.19
32 Skidmore	"	1.28
33 Elwood J'ct.	"	1.90
34 Beaver Dam	"	
35 Baldwin	"	
36 Pittsburgh	"	1.06
37 Springdale	"	
38 Freeport	"	1.56
39 Irwin	"	1.19
40 Greensburg	"	
41 Derry	"	1.20
42 Blairsville	"	
43 Saltsburg	"	1.25
44 Indiana	"	1.18
45 Cassandra	"	.88
46 Johnstown	"	1.59
47 Somerset	"	1.10
48 Confluence	"	.72
49 Lycippus	"	1.29
50 West Newton	"	1.20
51 Lock No. 4	"	.94
52 California	"	.72
53 Uniontown	"	.75
54 Greensboro	"	.66
55 Wellsburg	W. Va.	1.31
56 Claysville	Pa.	
57 Aleppo	"	.65
58 Smithfield	W. Va.	
59 Mannington	"	.60
60 Morgantown	"	.51
61 Fairmont	"	.46
62 Grafton	"	.49
63 Rowlesburg	"	.56
64 Terra Alta	"	.60
65 Grantsville	Md.	.43
66 Deer Park	"	.01
67 Oakland	"	.00
68 Parsons	W. Va.	
69 Elkins	"	.39
70 Beverly	"	1.00
71 Pickens	"	.91
72 Buckhannon	"	1.18
73 Phillipi	"	.69
74 Lost Creek	"	1.04
75 Weston	"	.60

Above rainfall is for 72 hours previous to 8 A.M. January 22, 1904.

THE LORD BALTO PRESS, BALTO MD



MAP SHOWING
LINES OF EQUAL RAINFALL
FOR FLOOD OF
MARCH 4, 1904
GAGE HEIGHT AT PITTSBURGH 26.9'

TOTAL RAINFALL INCHES

1	Alfred	N.Y.	
2	Bolivar	" "	1.47
3	Olean	" "	
4	Allegany	" "	
5	Humphrey	" "	
6	Franklinville	" "	1.45
7	Redhouse	" "	
8	Otto	" "	.95
9	Cherry Creek	" "	
10	Jamestown	" "	1.56
11	Westfield	" "	
12	Volusia	" "	1.48
13	Erie	Pa.	.60
14	Saegerstown	"	1.76
15	Warren	"	1.54
16	Smethport	"	
17	Coudertsport	"	1.50
18	St. Marys	"	1.85
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	3.14
22	Hawthorn	"	
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	3.02
26	Parkers L'ndg.	"	2.54
27	Oil City	"	2.40
28	Franklin	"	
29	Grove City	"	
30	Butler	"	
31	Greenville	"	1.30
32	Skidmore	"	1.48
33	Elwood J'ct.	"	2.16
34	Beaver Dam	"	
35	Baldwin	"	
36	Pittsburgh	"	1.87
37	Springdale	"	
38	Freeport	"	2.33
39	Irwin	"	2.02
40	Greensburg	"	.
41	Derry	"	1.38
42	Blairsville	"	
43	Saltsburg	"	2.20
44	Indiana	"	2.20
45	Cassandra	"	.75
46	Johnstown	"	1.64
47	Somerset	"	.50
48	Confluence	"	1.18
49	Lycippus	"	.85
50	West Newton	"	.70
51	Lock No. 4	"	2.15
52	California	"	1.19
53	Uniontown	"	1.04
54	Greensboro	"	.94
55	Wellsburg	W.Va.	
56	Claysville	Pa.	
57	Aleppo	"	1.51
58	Smithfield	W.Va	
59	Mannington	"	
60	Morgantown	"	.95
61	Fairmont	"	1.06
62	Grafton	"	.81
63	Rowlesburg	"	1.26
64	Terra Alta	"	.38
65	Grantsville	Md.	.58
66	Deer Park	"	.00
67	Oakland	"	1.00
68	Parsons	W. Va.	.65
69	Elkins	"	.92
70	Beverly	"	
71	Pickens	"	.70
72	Buckhannon	"	
73	Phillipi	"	.65
74	Lost Creek	"	1.06
75	Weston	"	.78

Above rainfall is for 96 hours previous to 8 A.M March 4, 1904.

THE LORD BALTO PRESS, BALTO MD

FLOOD OF MARCH 4, 1904.

The flood of March 4, 1904, reached its peak of 26.9 at 9 A. M., and began to fall almost immediately, but remained at a fairly high stage for a number of days, crossing the 22-foot mark again on the 8th, when the gage registered 23.0.

The rainfall causing the flood was not very uniformly distributed, being greatest on the Allegheny Basin, a large part of which received a precipitation of 2.0 inches or over. The maximum precipitation was 3.14 inches at Brookville, Pa., and the drainage areas in this region, those of the Clarion River, and Red Bank and Mahoning Creeks, received the greatest rainfall. There was very little, if any, snow on the ground at the time of this rise and the temperatures were exceptionally low for a flood period. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 8, shows its total amount and distribution.

The Clarion River, and Red Bank and Mahoning Creeks were the largest contributors to this flood, the Clarion being within 2 feet and Red Bank within 0.6 foot of maximum recorded stage. The Kiskiminetas, Youghiogheny and Cheat did not figure prominently in this rise.

The following table gives the gage heights at river stations during the flood period.

TABLE No. 23.

Daily Gage Heights at River Stations. Flood of March 4, 1904.

Station	Date														Highest recorded stage	
	February			March												
	27	28	29	1	2	3	4	5	6	7	8	9	10		Stage	Date
Brookville	1.0	1.0	1.0	3.8	2.6	a 6.6	5.0	3.0	2.5	10.0	6.0	4.0	3.0		14.0	June 1, 1889
Clarion	3.0	2.9	3.0	8.0	6.0	b 8.2	11.5	6.8	5.2	8.7	12.0	7.0	6.6		16.0	Mar. 20, 1905
Saltsburg	F	F	F	0.7	0.4	0.5	8.0	4.0	2.5	2.5	7.0	4.2	3.5		22.1	1859
Warren	1.4	1.2	1.2	2.2	5.1	6.6	8.6	7.1	6.6	7.1	11.1	10.0	8.8		17.4	Mar. 1865
Oil City	2.2	2.0	2.2	11.0	6.8	7.9	11.6	9.6	7.5	7.7	13.0	10.7	9.1		21.0	Mar. 17, 1865
Parker	3.1	3.1	3.3	8.0	8.5	c 11.0	15.8	12.0	8.2	10.0	14.9	12.0	9.7		28.0	Mar. 1865
Freeport	6.0	5.4	6.5	18.3	16.5	17.6	d 27.9	18.0	14.1	15.0	23.9	20.0	17.0		32.7	Feb. 18, 1891
Herr Island	5.4	5.0	6.7	18.0	19.1	16.5	29.1	21.3	15.2	15.8	25.1	22.4	17.0		36.9	Mar. 15, 1907
Rowlesburg	3.2	3.0	2.9	3.8	5.0	4.0	6.0	4.6	4.0	3.4	5.6	4.6	4.0		22.0	July 10, 1888
Confluence	2.6	2.2	2.1	4.2	3.7	3.1	6.2	4.6	3.6	3.7	5.8	4.4	3.4		18.6	Mar. 14, 1907
West Newton.	F	F	12.8	17.0	9.0	6.6	11.8	6.7	4.3	6.0	8.9	6.7	4.6		28.2	Mar. 14, 1907
Weston	-0.1	0.3	1.0	1.1	0.7	0.6	1.0	0.9	0.6	e 1.1	1.2	0.9	0.6		21.0	Oct. 13, 1890
Fairmont	15.8	15.8	17.0	18.4	18.0	17.2	19.5	18.0	17.3	f 17.0	19.5	18.0	16.9		37.0	July 10, 1888
Greensboro	8.7	8.5	8.8	11.4	12.4	11.0	15.2	12.5	10.5	10.5	13.9	12.5	10.6		39.0	July 10, 1888
Lock No. 4	9.5	8.9	9.5	13.3	15.0	13.8	18.7	16.8	13.2	12.5	19.5	16.9	13.5		42.0	July 11, 1888
Pittsburgh	4.8	4.1	5.6	15.0	16.7	14.6	g 26.5	19.8	13.7	13.7	23.0	20.5	15.2		35.5	Mar. 15, 1907
Wheeling	9.8	8.2	9.5	15.6	26.3	25.5	36.8	38.5	29.0	22.7	28.4	36.3	29.3		53.1	Feb. 7, 1884
Parkersburg	11.6	10.0	8.8	13.0	21.0	27.4	33.0	37.3	38.6	35.0	33.5	33.6	35.0		53.9	Feb. 9, 1884
Cincinnati	22.6	23.9	23.4	22.7	21.8	21.4	27.0	34.2	38.2	42.0	44.8	45.9	45.6		71.1	Feb. 14, 1884

a. Max. 13.4, 2 P.M.
b. Max. 14.0, 12 Midnight.
c. Max. 16.6, 11 P.M.
d. Max. 28.9, about 1 A.M.
e. Max. 6.6, 4 P.M.
f. Max. 20.6, 6 P.M.
g. Max. 26.9, 9 A.M.
F. Frozen.

FLOOD OF MARCH 22, 1905.

The flood of March 22, 1905, was the longest flood on record at Pittsburgh, rising above the 22-foot mark about 3 A. M. on the 20th and remaining above until about 5 P. M. on the 23rd, a period of 86 hours. There were two peaks to this flood, the first rising to the 27.9-foot stage at 8 P. M. on the 20th, and the second to 29.0 feet at 8 A. M. on the 22nd. Between these two peaks the stage dropped to 27.0 feet at 12 noon on the 21st.

The rainfall causing this flood was not extremely great at any point within the watershed, but 90 per cent of the entire Allegheny and Monongahela Basins had a precipitation of from 1.5 to 2.0 inches. This rainfall was spread out over the four days from the 19th to 22nd, inclusive, and kept up a high stage in the streams for a number

of days. It is shown on Plate 52, Chapter VII, and the map of the basins, Plate 9, shows its total amount and distribution.

The Monongahela crest arrived after the Pittsburgh peak had begun to subside, as the maximum stage at Lock No. 4 did not occur until the 22nd. The Allegheny was the main cause of the flood and its high stage was due principally to the unprecedented height reached by the Clarion, the gage at Clarion registering 16.0 feet on the 20th, 0.8 foot above the previous recorded maximum of 15.2 feet, reached in 1894. The Allegheny at Kittanning reached the greatest height on record and was only about 0.5 foot lower than during the great flood of 1865, while it was 12.9 feet higher than in March, 1907. The Kiskiminetas was not an important contributor to this flood, but in spite of that fact, the Allegheny at Freeport rose to within 0.7 foot of record height.

The following table gives the gage heights at river stations during the flood period.

TABLE No. 24.

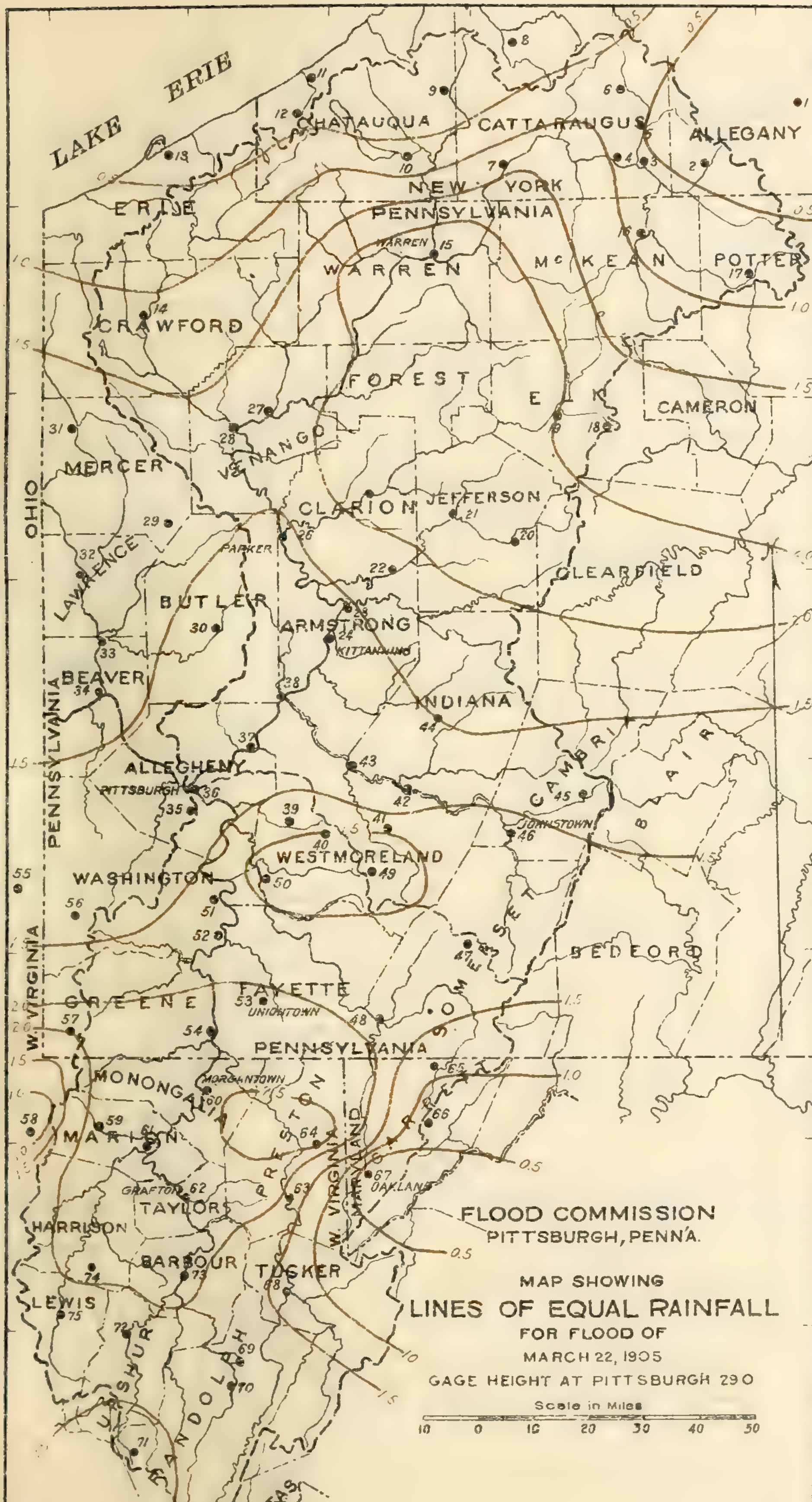
Daily Gage Heights at River Stations. Flood of March 22, 1905.

Station	Date										Highest recorded stage	
	March											
	16	17	18	19	20	21	22	23	24	25	Stage	Date
Brookville	1.0	1.0	1.4	a 5.0	5.8	4.0	3.4	2.8	2.0	2.0	14.0	June 1, 1889
Clarion	2.6	3.0	7.4	10.8	16.0	11.0	9.6	7.7	6.8	7.3	16.0	Mar. 20, 1905
Saltsburg	2.7	3.4	5.0	5.5	9.0	b 7.0	7.5	5.0	4.0	4.0	22.1	1859
Warren	F	1.5	1.7	10.1	13.5	12.0	12.1	10.5	9.4	10.0	17.4	Mar. 1865
Oil City	3.0	2.8	4.2	15.5	17.6	14.9	14.1	12.3	11.1	11.0	21.0	Mar. 17, 1865
Parker	----	----	17.0	12.5	22.0	17.0	15.0	13.8	12.0	11.0	28.0	Mar. 1865
Kittanning	----	----	13.0	18.2	c 28.2	24.8	21.8	18.4	16.5	16.0	29.3	1865
Freeport	7.1	6.7	11.0	16.8	d 31.2	28.5	26.3	21.5	18.0	17.4	32.7	Feb. 18, 1891
Herr Island	7.5	7.5	9.8	16.6	28.5	e 30.0	30.0	25.4	19.7	17.5	36.9	Mar. 15, 1907
Rowlesburg	3.4	3.2	3.2	3.8	3.8	f 7.2	7.0	5.0	4.5	4.6	22.0	July 10, 1888
Confluence	3.5	3.3	6.0	6.5	8.0	g 7.9	7.2	5.6	4.8	4.5	18.6	Mar. 14, 1907
West Newton	4.5	4.0	7.5	8.9	13.1	h 11.6	13.0	8.9	6.4	5.8	28.2	Mar. 14, 1907
Weston	0.4	0.3	0.1	0.1	0.3	6.4	0.7	0.4	0.4	0.6	21.0	Oct. 13, 1890
Fairmont	15.5	15.4	15.3	15.2	17.0	20.7	21.9	18.6	17.0	16.9	37.0	July 10, 1888
Greensboro	8.9	8.9	9.1	9.2	12.8	15.0	19.0	13.8	11.3	10.9	39.0	July 10, 1888
Lock No. 4	9.9	9.4	9.6	9.9	14.4	16.5	**27.2**	**20.5**	13.3	12.9	42.0	July 11, 1888
Pittsburgh	6.6	6.5	8.5	14.2	**24.7**	27.3	**29.0**	**24.1**	17.6	15.3	35.5	Mar. 15, 1907
Wheeling	11.3	10.5	10.9	14.9	24.9	38.3	j 42 0	42.0	35.9	27.3	53.1	Feb. 7, 1884
Parkersburg	12.5	11.4	10.5	11.0	15.0	29.0	**39.1**	**k 41.6**	41.0	37.0	53.9	Feb. 9, 1884
Cincinnati	40.9	35.6	29.6	25.3	22.3	21.2	**28.8**	**37.1**	42.2	45.0	71.1	Feb. 14, 1884

a. Max. 7.6.
b. Max. 9.2, 6 P.M.
c. Max. 28.8.
d. Max. 32.0.
e. Max. 31.0.
f. Max. 7.9, 2 P.M.
g. Max. 8.8.
h. Max. 14.1.
j. Max. 42.9.
k. Max. 42.4.
F. Frozen.

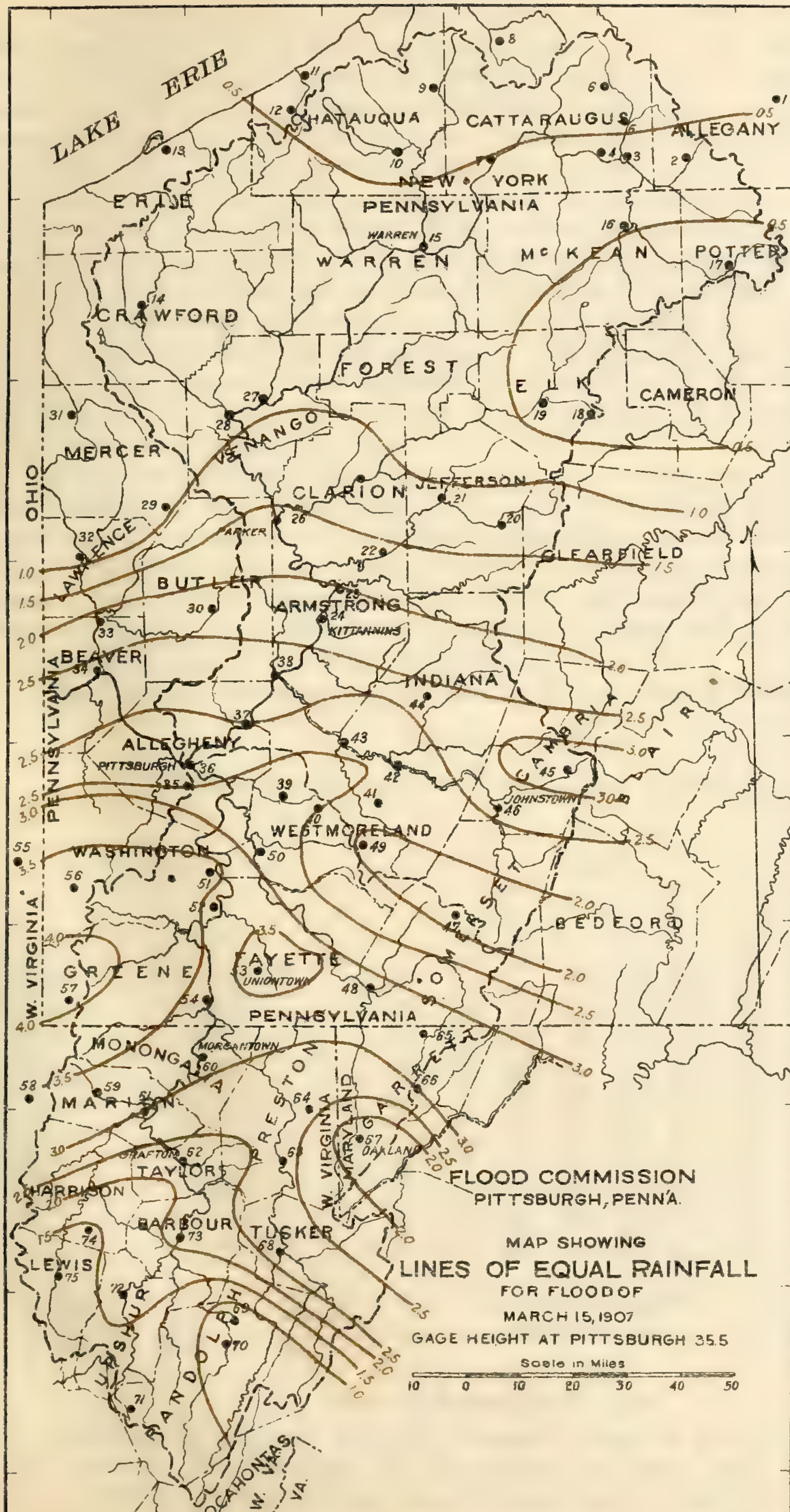
FLOOD OF MARCH 15, 1907.

The flood of March 15, 1907, the greatest by 2.2 feet that Pittsburgh has ever experienced, was caused by a very unevenly distributed rainfall, accompanied by high temperatures, causing the run-off of a considerable amount of snow, and the breaking-up of the ice in the rivers and their tributaries. The month of February and the first part of March had been unusually cold, and the ground was frozen and in condition to cause a high rate of run-off. There was a rainfall on the 10th amounting to between 0.50 and 0.70 inch at some parts of the basin, while the 11th and 12th had light rainfall, unevenly distributed. The principal rain, which occurred on the 13th and 14th, was light over the northern Allegheny Basin; but from Mahoning, Pa., on the north, to Philippi, W. Va., on the south, the precipitation was over 2 inches, reaching a maximum of 4.25 inches at Aleppo, Pa., 3.45 inches at Grantsville, Md., and 3.25 inches at Cassandra, Pa. The highest temperatures were at this time, and the ice and snow came out with the rain run-off. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 10, shows its total amount and distribution.



TOTAL RAINFALL		INCHES
1 Alfred	N.Y.	
2 Bolivar	" "	.25
3 Olean	" "	
4 Allegany	" "	
5 Humphrey	" "	
6 Franklinville	" "	.60
7 Redhouse	" "	
8 Otto	" "	.21
9 Cherry Creek	" "	
10 Jamestown	" "	.65
11 Westfield	" "	
12 Volusia	" "	.40
13 Erie	Pa.	.40
14 Saegerstown	"	1.07
15 Warren	"	2.42
16 Smethport	"	
17 Coudertsport	"	
18 St. Marys	"	1.94
19 Ridgway	"	
20 Dubois	"	
21 Brookville	"	2.14
22 Hawthorn	"	
23 Mahoning	"	
24 Kittanning	"	
25 Clarion	"	2.32
26 Parkers L'nd'g.	"	1.38
27 Oil City	"	1.68
28 Franklin	"	1.73
29 Grove City	"	
30 Butler	"	
31 Greenville	"	1.87
32 Skidmore	"	1.82
33 Elwood J'ct.	"	1.60
34 Beaver Dam	"	1.91
35 Baldwin	"	
36 Pittsburgh	"	1.10
37 Springdale	"	
38 Freeport	"	1.14
39 Irwin	"	1.67
40 Greensburg	"	
41 Derry	"	1.54
42 Blairsville	"	
43 Saltsburg	"	1.22
44 Indiana	"	1.52
45 Cassandra	"	1.00
46 Johnstown	"	1.78
47 Somerset	"	1.94
48 Confluence	"	1.90
49 Lycippus	"	1.09
50 West Newton	"	1.28
51 Lock No. 4	"	1.81
52 California	"	1.76
53 Uniontown	"	
54 Greensboro	"	2.20
55 Wellsburg	W.Va.	
56 Claysville	Pa.	1.28
57 Aleppo	"	2.16
58 Smithfield	W.Va	.56
59 Mannington	"	2.28
60 Morgantown	"	2.42
61 Fairmont	"	
62 Grafton	"	2.23
63 Rowlesburg	"	
64 Terra Alta	"	2.67
65 Grantsville	Md.	1.16
66 Deer Park	"	.60
67 Oakland	"	.32
68 Parsons	W.Va.	1.40
69 Elkins	"	1.75
70 Beverly	"	
71 Pickens	"	1.44
72 Buckhannon	"	
73 Philipi	"	2.11
74 Lost Creek	"	2.17
75 Weston	"	1.86

Above rainfall is for 72 hours previous to 8 A.M. March 21, 1905



TOTAL RAINFALL		INCHES
1 Alfred	N.Y.	
2 Bolivar	" "	.56
3 Olean	" "	
4 Allegany	" "	.64
5 Humphrey	" "	
6 Franklinville	" "	.19
7 Redhouse	" "	
8 Otto	" "	.05
9 Cherry Creek	" "	
10 Jamestown	" "	.41
11 Westfield	" "	
12 Volusia	" "	
13 Erie	Pa.	.65
14 Saegerstown	"	.52
15 Warren	"	.77
16 Smethport	"	
17 Coudertsport	"	
18 St. Marys	"	
19 Ridgway	"	.35
20 Dubois	"	
21 Brookville	"	
22 Hawthorn	"	
23 Mahoning	"	
24 Kittanning	"	
25 Clarion	"	1.16
26 Parkers L'nd'g.	"	1.54
27 Oil City	"	
28 Franklin	"	.80
29 Grove City	"	.94
30 Butler	"	
31 Greenville	"	.81
32 Skidmore	"	.60
33 Elwood J'ct.	"	2.10
34 Beaver Dam	"	2.64
35 Baldwin	"	
36 Pittsburgh	"	1.87
37 Springdale	"	2.57
38 Freeport	"	2.77
39 Irwin	"	3.09
40 Greensburg	"	
41 Derry	"	2.90
42 Blairsville	"	
43 Saltsburg	"	2.32
44 Indiana	"	2.55
45 Cassandra	"	3.25
46 Johnstown	"	2.51
47 Somerset	"	1.58
48 Confluence	"	3.13
49 Lycippus	"	1.87
50 West Newton	"	2.83
51 Lock No. 4	"	3.60
52 California	"	3.27
53 Uniontown	"	3.74
54 Greensboro	"	3.24
55 Wellsburg	W. Va.	
56 Claysville	Pa.	3.70
57 Aleppo	"	4.25
58 Smithfield	W. Va.	
59 Mannington	"	
60 Morgantown	"	3.10
61 Fairmont	"	3.08
62 Grafton	"	2.20
63 Rowlesburg	"	2.58
64 Terra Alta	"	2.79
65 Grantsville	Md.	3.45
66 Deer Park	"	3.05
67 Oakland	"	1.50
68 Parsons	W. Va.	3.00
69 Elkins	"	.76
70 Beverly	"	
71 Pickens	"	1.35
72 Buckhannon	"	
73 Phillipi	"	2.10
74 Lost Creek	"	1.42
75 Weston	"	1.70

Above rainfall is for 48 hours previous to 8 A.M March 15, 1907.

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The contribution of the northern Allegheny to this flood was unusually small on account of the light rainfall on the upper part of its basin. The gage at Clarion, on the Clarion River, recorded only 12.0 feet on the 14th, as against 16.0 feet on March 20, 1905. The Allegheny at Kittanning reached only 15.9 feet, whereas the stage in March, 1905, was 28.8 feet; and at Freeport, below the mouth of the Kiskiminetas River, it reached a maximum of 28.0 feet at 1.15 A. M. on the 15th, 4.7 feet lower than the maximum of 32.7 feet reached in February, 1891. The Kiskiminetas, however, was nearly at record stage, reaching a gage height, at Saltsburg, of 21.0 feet at 5.00 P. M. on the 14th, only about a foot lower than the maximum recorded stage at this point, which occurred during the flood of 1859.

The Monongahela at Lock No. 4, Pa., reached a stage of 37.4 feet on March 14, as against the maximum of 42.0 feet on July 11, 1888. The Youghiogheny was the only large tributary which exceeded previous maximum recorded stage, the gage at West Newton registering 28.2 feet on the afternoon of the 14th, while the previous maximum was only 22.0 feet.

It is evident that the unprecedented stage at Pittsburgh was caused principally by the Youghiogheny and Kiskiminetas Rivers. The maximum on each occurred on the afternoon of the 14th, and as the time of travel from West Newton and from Saltsburg to Pittsburgh is about 15 hours, the crests of both these streams arrived at Pittsburgh in the early morning of the 15th, when the maximum stage of 35.5 feet was reached. Had the upper Allegheny received a rainfall equal to that on the Monongahela, a much higher stage at Pittsburgh would have resulted.

The following table gives the gage heights at river stations during the flood period.

TABLE No. 25.

Daily Gage Heights at River Stations. Flood of March 15, 1907.

Station	Date: March 10	11	12	13	14	15	16	17	Highest recorded stage: Stage	Date
Clarion	2.9	2.8	2.8	3.5	a 8.0	8.5	6.9	6.5	16.0	Mar. 20, 1905
Saltsburg	4.2	2.7	1.3	5.0	b 18.4	13.4	6.0	5.0	22.1	1859
Warren	1.4	1.4	1.5	1.6	3.5	6.2	6.0	6.5	17.4	Mar. 1865
Franklin	5.2	5.3	4.1	4.3	c 8.0	8.4	8.8	8.2	----	Mar. 17, 1865
Parker	F	F	F	5.5	d 10.0	7.5	6.5	6.0	28.0	Mar. 1865
Kittanning	4.7	4.6	4.7	8.6	14.0	15.9	14.2	13.0	29.3	1865
Freeport	4.9	4.9	5.0	9.7	22.4	e 25.7	16.5	15.0	32.7	Feb. 18, 1891
Springdale	9.2	8.8	9.2	14.1	27.4	32.4	21.2	19.2	32.4	Mar. 15, 1907
Herr Island	5.8	6.0	9.3	13.2	31.6	f 36.4	23.6	17.2	36.9	Mar. 15, 1907
Rowlesburg	3.9	6.2	5.0	8.4	g 8.2	7.6	5.0	4.2	22.0	July 10, 1888
Confluence	2.6	2.8	2.2	11.0	h 17.2	11.4	7.0	5.0	18.6	Mar. 14, 1907
West Newton	2.9	3.1	3.0	7.9	j 26.3	21.9	10.5	7.6	28.2	Mar. 14, 1907
Weston	0.8	1.2	0.7	1.1	8.7	4.5	3.0	2.2	21.0	Oct. 13, 1890
Fairmont	16.8	21.5	19.8	23.0	k 24.5	22.2	19.0	17.1	37.0	July 10, 1888
Greensboro	10.0	14.6	14.1	18.7	27.2	21.0	14.2	11.2	39.0	July 10, 1888
Lock No. 4	11.4	13.9	19.2	21.0	37.4	35.0	22.6	15.5	42.0	July 11, 1888
Pittsburgh	5.3	5.6	9.8	12.7	30.8	m 35.1	22.8	15.7	35.5	Mar. 15, 1907
Wheeling	8.5	9.3	9.5	17.5	37.9	n 47.8	48.9	38.0	53.1	Feb. 7, 1884
Parkersburg	9.6	11.9	12.2	18.0	37.0	48.1	51.4	50.9	53.9	Feb. 9, 1884
Cincinnati	26.1	26.1	25.2	24.5	23.6	22.3	21.5	o 21.0	71.1	Feb. 14, 1884

a. Max. 12.0, 11 A.M.
b. Max. 21.0, 5 P.M.
c. Max. 10.8, 4 P.M.
d. Max. 18.0, 5 P.M.
e. Max. 28.0, 1.15 P.M.
f. Max. 36.9.
g. Max. 9.2, 6.00 P.M.
h. Max. 18.6.
j. Max. 28.2, 1 to 5 P.M.
k. Max. 25.6, 3 P.M.
m. Max. 35.5, 5 A.M.
n. Max. 50.1, 9 P.M.
o. Max. 62.1, 11 P.M., Mar. 1[illegible]
F. Frozen.

FLOOD OF FEBRUARY 16, 1908.

The flood of February 16, 1908, reached a stage of 30.7 feet at Pittsburgh at about 1.00 P. M., remaining at this height a little over two hours. The rainfall was not exceptionally heavy, but was general over both basins, averaging from

1.0 inch to 1.5 inches, with a maximum of 2.04 inches at Parker, the latter part of which was in the form of snow. The first part of the month was unusually cold and there was a large snowfall, especially in the mountain districts. After the 10th of the month it became steadily warmer until the 15th, when the highest temperature for the month was reached. There were scattering showers on the 13th, but the rainfall causing the flood came on the 14th and 15th, and the resulting run-off was largely augmented by melting snow. The streams were low and quite generally frozen and the ice came out with the high water. The sudden drop in temperature on the night of the 15th, and the continued cold on the 16th, stopped the melting of the snow and changed the rain to snow, preventing a higher flood, and causing a rapid drop in the streams. The Local Forecaster of the U. S. Weather Bureau had predicted a stage of 31.0 feet and the precautions taken as a result of this excellent forecast considerably lessened the flood damage. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 11, shows its total amount and distribution.

It is interesting to note that in this flood the maximum stages of the Clarion at Clarion and of the Allegheny at Freeport were about the same as in March, 1907, while the Allegheny at Kittanning reached a point 9 feet higher, and the Cheat at Rowlesburg 2.8 feet higher. On the other hand, the Kiskiminetas at Saltsburg was 10 feet lower, the Monongahela at Lock No. 4, 9 feet lower, and the Youghiogheny at West Newton 10 feet lower than in March, 1907. The crests of the upper Allegheny, the Cheat and the Clarion, however, did not reach Pittsburgh until after the maximum stage had passed that point, and it is evident, therefore, that the maximum discharges of the Monongahela, Youghiogheny and Kiskiminetas, arriving at Pittsburgh at nearly the same time on the 16th, were responsible for the height of the flood.

The following table gives the gage heights at river stations during the flood period.

TABLE No. 26.

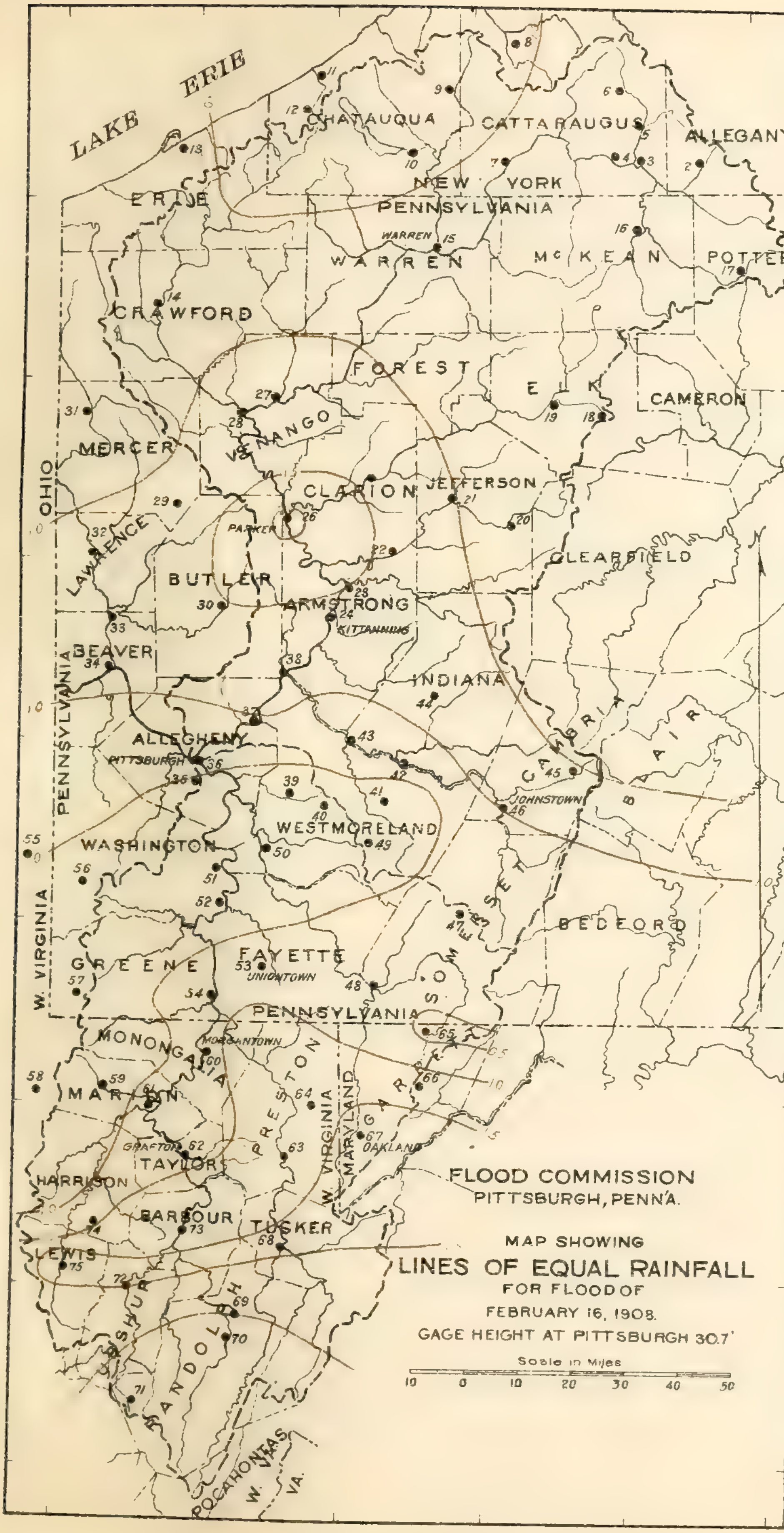
Daily Gage Heights at River Stations. Flood of February 16, 1908.

Station	Date										Highest recorded stage	
	February											
	10	11	12	13	14	15	16	17	18	19	Stage	Date
Clarion	3.0	2.9	2.9	3.1	6.0	a 6.2	11.0	6.6	5.8	5.3	16.0	Mar. 20, 1905
Saltsburg	F	F	F	9.5	9.9	b 7.6	9.5	5.0	3.5	2.8	22.1	1859
Avonmore	10.4	10.5	10.8	12.8	14.0	20.3	21.4	11.8	8.8	7.8	---	
Warren	1.2	1.2	1.2	1.6	4.0	c 9.8	11.0	9.7	8.3	7.0	17.4	Mar. 1865
Franklin	4.9	4.8	4.5	4.0	7.9	10.6	d16.2	13.1	10.6	8.7	---	Mar. 17, 1865
Parker	5.0	5.0	4.8	4.7	6.3	8.5	17.5	11.6	7.8	7.0	28.0	Mar. 1865
Kittanning	8.0	8.0	* 9.0	* 10.0	11.0	18.9	24.3	18.7	15.4	12.8	29.3	1865
Freeport	3.5	3.7	4.3	4.8	7.0	20.3	28.4	22.0	17.6	13.8	32.7	Feb. 18, 1891
Springdale	10.7	10.8	10.8	11.0	17.0	22.0	33.0	27.3	21.9	17.9	32.4	Mar. 15, 1907
Herr Island	4.0	3.7	3.9	5.6	8.5	19.9	e 31.9	27.5	19.6	14.8	36.9	Mar. 15, 1907
Rowlesburg	F	F	F	6.0	6.6	f 8.0	8.4	5.5	4.5	4.0	22.0	July 10, 1888
Confluence	F	F	F	F	3.8	7.5	8.2	5.0	3.5	3.0	18.6	Mar. 14, 1907
West Newton	F	F	F	F	8.0	g 12.4	16.5	7.8	5.8	4.1	28.2	Mar. 14, 1907
Weston	0.4	0.0	0.0	-0.2	0.0	h 2.8	1.8	1.0	0.4	0.4	21.0	Oct. 13, 1890
Fairmont	15.8	15.8	15.8	17.0	18.5	19.8	22.4	19.8	17.0	16.6	37.0	July 10, 1888
Greensboro	8.3	8.5	8.5	10.4	13.6	15.8	j20.8	14.7	11.4	10.0	39.0	July 10, 1888
Lock No. 4	10.5	10.4	10.5	11.5	16.1	20.3	28.5	21.5	15.8	12.7	42.0	July 11, 1888
Pittsburgh	3.6	3.1	3.4	5.0	7.7	17.8	k29.8	26.0	17.5	13.1	35.5	Mar. 15, 1907
Wheeling	8.0	7.0	6.9	7.9	10.8	19.8	34.0	m42.0	39.2	29.3	53.1	Feb. 7, 1884
Parkersburg	10.5	9.5	9.3	9.5	12.2	21.7	30.0	37.2	n 41.0	39.9	53.9	Feb. 9, 1884
Cincinnati	29.6	25.8	23.5	22.4	21.0	34.5	42.2	45.0	46.8	p 49.2	71.1	Feb. 14, 1884

a. Max. 12.0, 5 P.M.
b. Max. 11.0, 6 P.M.
c. Max. 12.2, 4 P.M.
d. Max. 16.4, 10 P.M.
e. Max. 32.6, 1 P.M.
f. Max. 11.0, 4 to 6 P.M.
g. Max. 17.5, 10 P.M.
h. Max. 10.6, 6 P.M.
j. Max. 22.0, 1 A.M.
k. Max. 30.0, 1 to 3.57 P.M.
m. Max. 42.8, 10 P.M.
n. Max. 41.2.
p. Max. 51.3, Feb. 20.
*Interpolated.
F. Frozen.

FLOOD OF MARCH 20, 1908.

The flood of March 20, 1908, which reached a stage of 27.3 feet at Pittsburgh, at

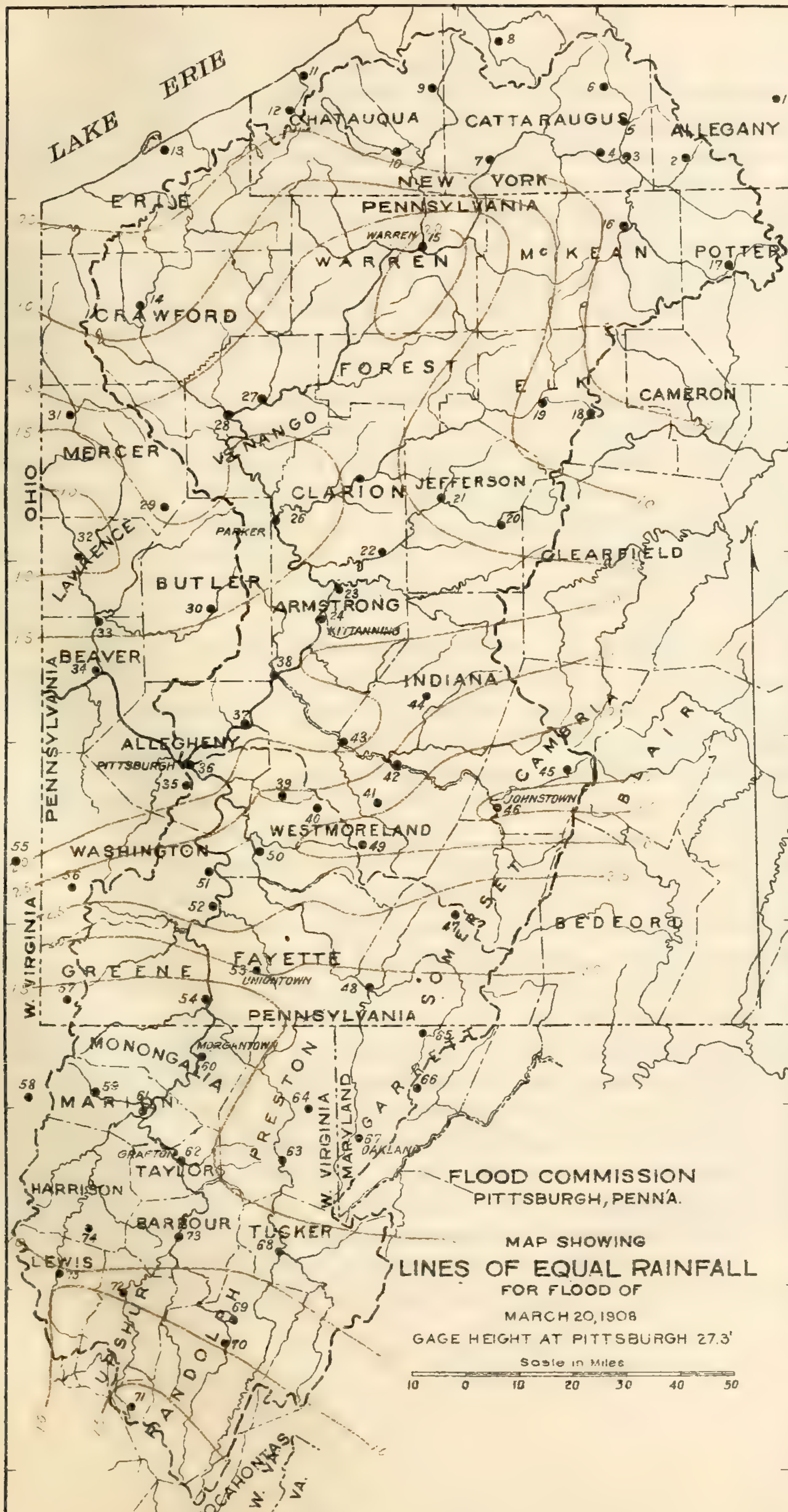


FLOOD COMMISSION
PITTSBURGH, PENN'A.

MAP SHOWING
LINES OF EQUAL RAINFALL
FOR FLOOD OF
FEBRUARY 16, 1908.
GAGE HEIGHT AT PITTSBURGH 30.7'

TOTAL RAINFALL		INCHES
1 Alfred	N.Y.	
2 Bolivar	" "	
3 Olean	" "	
4 Allegany	" "	1.20
5 Humphrey	" "	
6 Franklinville	" "	1.25
7 Redhouse	" "	
8 Otto	" "	.37
9 Cherry Creek	" "	
10 Jamestown	" "	
11 Westfield	" "	
12 Volusia	" "	.66
13 Erie	Pa.	1.08
14 Saegerstown	"	1.27
15 Warren	"	1.23
16 Smethport	"	
17 Coudertsport	"	
18 St. Marys	"	1.25
19 Ridgway	"	
20 Dubois	"	
21 Brookville	"	
22 Hawthorn	"	
23 Mahoning	"	
24 Kittanning	"	
25 Clarion	"	1.40
26 Parkers L'nd'g.	"	2.04
27 Oil City	"	
28 Franklin	"	.80
29 Grove City	"	1.14
30 Butler	"	
31 Greenville	"	1.37
32 Skidmore	"	.85
33 Elwood J'ct.	"	.86
34 Beaver Dam	"	.97
35 Baldwin	"	1.10
36 Pittsburgh	"	.60
37 Springdale	"	1.01
38 Freeport	"	1.08
39 Irwin	"	1.31
40 Greensburg	"	
41 Derry	"	1.16
42 Blairsville	"	
43 Saltsburg	"	.72
44 Indiana	"	1.40
45 Cassandra	"	
46 Johnstown	"	.98
47 Somerset	"	.83
48 Confluence	"	.70
49 Lycippus	"	1.13
50 West Newton	"	1.30
51 Lock No. 4	"	1.17
52 California	"	1.10
53 Uniontown	"	.90
54 Greensboro	"	.72
55 Wellsburg	W. Va.	.93
56 Claysville	Pa.	1.38
57 Aleppo	"	1.32
58 Smithfield	W. Va.	
59 Mannington	"	1.19
60 Morgantown	"	1.02
61 Fairmont	"	.95
62 Grafton	"	.80
63 Rowlesburg	"	1.18
64 Terra Alta	"	1.32
65 Grantsville	Md.	.40
66 Deer Park	"	1.27
67 Oakland	"	1.65
68 Parsons	W. Va.	1.55
69 Elkins	"	1.03
70 Beverly	"	
71 Pickens	"	.60
72 Buckhannon	"	1.54
73 Phillipi	"	1.43
74 Lost Creek	"	.97
75 Weston	"	1.54

Above rainfall is for 72 hours previous to 8 A.M. Feb'y 16, 1908



TOTAL RAINFALL			INCHES
1	Alfred	N.Y.	
2	Bolivar	" "	
3	Olean	" "	
4	Allegany	" "	.39
5	Humphrey	" "	
6	Franklinville	" "	.20
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	.24
11	Westfield	" "	
12	Volusia	" "	
13	Erie	Pa.	.09
14	Saegerstown	"	.76
15	Warren	"	2.17
16	Smethport	"	
17	Coudertsport	"	
18	St. Marys	"	.60
19	Ridgway	"	
20	Dubois	"	
21	Brookville	"	
22	Hawthorn	"	
23	Mahoning	"	
24	Kittanning	"	
25	Clarion	"	1.60
26	Parkers L'ndg.	"	1.24
27	Oil City	"	
28	Franklin	"	1.40
29	Grove City	"	1.79
30	Butler	"	
31	Greenville	"	1.52
32	Skidmore	"	.80
33	Elwood J'ct.	"	1.32
34	Beaver Dam	"	1.60
35	Baldwin	"	
36	Pittsburgh	"	1.49
37	Springdale	"	1.85
38	Freeport	"	1.98
39	Irwin	"	2.50
40	Greensburg	"	
41	Derry	"	2.92
42	Blairsville	"	
43	Saltsburg	"	1.77
44	Indiana	"	2.37
45	Cassandra	"	
46	Johnstown	"	3.55
47	Somerset	"	2.04
48	Confluence	"	1.98
49	Lycippus	"	3.19
50	West Newton	"	2.94
51	Lock No. 4	"	2.57
52	California	"	2.73
53	Uniontown	"	2.17
54	Greensboro	"	1.46
55	Wellsburg	W. Va.	1.84
56	Claysville	Pa.	2.76
57	Aleppo	"	1.35
58	Smithfield	W. Va.	1.19
59	Mannington	"	1.17
60	Morgantown	"	1.39
61	Fairmont	"	1.18
62	Grafton	"	1.42
63	Rowlesburg	"	1.75
64	Terra Alta	"	1.65
65	Grantsville	Md.	1.97
66	Deer Park	"	1.70
67	Oakland	"	1.80
68	Parsons	W. Va.	1.36
69	Elkins	"	.75
70	Beverly	"	
71	Pickens	"	1.60
72	Buckhannon	"	
73	Phillipi	"	1.12
74	Lost Creek	"	1.17
75	Weston	"	.96

Above rainfall is for 48 hours previous to 8 A. M. March 19, 1908

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1.00 A. M., where it remained for three hours, was preceded by the following weather and stream conditions.

During the cold weather following the flood of February 16, the precipitation was in the form of snow, and the streams dropped to points approximately as low as before this rise. The rainfall through the first half of March caused two fairly high stages at Pittsburgh, 20.5 feet on the 3rd, and 20.9 feet on the 7th; and the stage remained high from the 7th on, owing to the melting of the snow by the generally warm weather, and to the frequent showers. As a result, on the 18th and 19th, when the principal rain of the month came, the streams were already above normal, and less additional run-off was required to bring them to flood stage. In this feature, this flood was different from the February flood, preceding which the streams were all frozen at fairly low stages; for the stage at Pittsburgh, 3 days before the day of the crest, was 15.5 feet as against 5.0 feet in the February flood.

The rainfall of the 18th and 19th was fairly uniform in its distribution. With the exception of the extreme northern part of the Allegheny Basin, it was above 1.0 inch, and was above 1.5 inches over three-fourths of the combined basins. The maximum rainfall for the two days was 3.55 inches, at Johnstown, Pa., and the storm seemed to reach its greatest intensity in this region, the rainfall at Lycippus being 3.19 inches for the 24 hours preceding 8 A. M. on the 18th. The rainfall causing this flood is shown on Plate 52, Chapter VII, and the map of the basins, Plate 12, shows its total amount and distribution.

A glance at this map readily explains why the Kiskiminetas was so large a contributor to this flood, as the region of greatest rainfall centered around its watershed. This stream reached, at Saltsburg, a height of 18.0 feet at 2 P. M. on the 19th, 7 feet above the maximum of the February flood; and at Avonmore a height of 30.8 feet, at 4 P. M., on the 19th, 8.2 feet above the maximum of the February flood. The time of movement from Avonmore to Pittsburgh would bring this crest to Pittsburgh at about peak time. The Clarion was at about the same height as in the February flood, but its maximum flow, as in the earlier flood, reached Pittsburgh after peak time. The Allegheny at Kittanning was 5 feet lower than in the February flood, but its crest of 19.8 feet occurred at 6 P. M. on the 19th, so that 9 hours, the approximate time of movement of its flood wave to Pittsburgh, would bring it there at peak time; whereas, the maximum in the February flood did not occur until 9 P. M. on the 16th, 8 hours after the arrival of the crest of the flood at Pittsburgh. It is noteworthy that, in both these floods, the Kittanning maximum was greater than in the flood of March, 1907.

The Cheat River at Rowlesburg was 4.5 feet higher than in the February flood, but its maximum height of 15.5 feet did not occur until 2 A. M. on the 20th, so that its flood water arrived at Pittsburgh too late to contribute to the flood peak. The Monongahela at Lock No. 4 was 5.5 feet lower than in February, and its crest of 23.0 feet came too late to arrive at Pittsburgh at peak time.. The Youghiogheny at West Newton reached a maximum of 15.1 feet on the 19th, 2.9 feet lower than in February; but, as in the former flood, its water arrived at Pittsburgh at peak time.

The following table gives the gage heights at river stations during the flood period.

TABLE No. 27.

Daily Gage Heights at River Stations. Flood of March 20, 1908.

Station	Date										Highest recorded stage	
	March											
	14	15	16	17	18	19	20	21	22	23	Stage	Date
Clarion	8.8	8.5	10.5	7.4	6.8	a 10.3	9.0	6.0	5.0	3.8	16.0	Mar. 20, 1905
Saltsburg	5.2	5.2	6.0	4.7	3.5	b 16.5	9.2	5.5	4.0	3.4	22.1	1859
Avonmore	10.8	10.9	13.1	9.8	10.6	c 30.1	17.9	11.9	9.6	8.9	----	
Warren	8.0	8.5	10.0	9.2	8.3	8.1	7.2	6.3	5.3	4.6	17.4	Mar. 1865
Franklin	8.9	9.6	11.0	10.6	9.1	10.9	9.6	7.8	6.5	5.8	----	Mar. 17, 1865
Parker	8.7	10.5	11.8	11.0	10.1	d 12.0	11.4	9.4	7.0	6.3	28.0	Mar. 1865
Kittanning	14.5	15.4	16.8	16.5	16.9	18.7	17.6	13.9	11.2	10.4	29.3	1865
Freeport	14.2	16.5	18.0	17.8	15.2	e 22.7	23.0	15.3	12.9	11.0	32.7	Feb. 18, 1891
Springdale	18.0	20.3	21.5	21.9	19.4	25.8	28.8	20.3	17.1	15.0	32.4	Mar. 15, 1907
Herr Island	14.0	16.4	17.1	17.8	15.5	22 6	28.6	19.1	14.2	11.8	36.9	Mar. 15, 1907
Rowlesburg	3.2	3.0	2.8	2.7	2.6	f 5.8	6.3	4.8	4.2	3.9	22.0	July 10, 1888
Confluence	4.8	4.3	4.4	3.6	2.7	9.0	6.5	4.3	3.4	3.0	18.6	Mar. 14, 1907
West Newton	5.7	5.9	5.9	5.5	4.4	g 15.1	12.6	7.1	5.4	4.6	28.2	Mar. 14, 1907
Weston	-0.2	-0.2	-0.2	0.0	0.0	1.1	0.4	0.0	0.0	0.0	21.0	Oct. 13, 1890
Fairmont	16.2	16.0	15.9	15.9	15.7	18.2	19.5	17.9	16.8	16.2	37.0	July 10, 1888
Greensboro	9.5	9.2	9.2	9.3	9.0	12.8	15.5	12.3	10.4	9.5	39.0	July 10, 1888
Lock No. 4	11.9	11.7	11.3	11.0	10.9	17.5	23.0	17.0	14.0	12.1	42.0	July 11, 1888
Pittsburgh	12.0	14.1	14.8	15.5	13.0	20.4	h26.7	17.8	13.2	10.7	35.5	Mar. 15, 1907
Wheeling	17.7	19.2	21.2	22.7	22.3	26.7	j 36.7	38.4	29.5	20.9	53.1	Feb. 7, 1884
Parkersburg	20.0	19.4	20.0	21.4	23.0	25.3	33.2	37.7	38.0	32.7	53.9	Feb. 9, 1884
Cincinnati	49.5	45.0	41.8	37.5	34.8	34.8	38.0	41.0	44.5	47.5	71.1	Feb. 14, 1884

a. Max. 12.0, 5 P.M.
b. Max. 18.0, 2 P.M.
c. Max. 30.8, 4 P.M.
d. Max. 12.8, 4 P.M.
e. Max. 26.7, 8 P.M.
f. Max. 6.8, 2 P.M.
g. Max. 17.8, 4 P.M.
h. Max. 27.3, 2.00 P.M.
j. Max. 39.6, 7.40 P.M.

RELATION OF ALLEGHENY AND MONONGAHELA RIVERS TO FLOODS AT PITTSBURGH.

Although the drainage area of the Allegheny River is 58 per cent larger than that of the Monongahela, the Allegheny collects its flood waters more rapidly, and, owing to its steeper channel profile, moves them on to Pittsburgh at greater speed. This is clear, insofar as travel down the main river is concerned, from a study of the diagram, Plate 53, Chapter VII, showing time of movement of floods on the Allegheny and Monongahela Rivers.

It would seem, therefore, that Pittsburgh floods, when due to a rise in both rivers, are caused by the crest of the Allegheny, added to whatever part of the Monongahela flood water has arrived in Pittsburgh in time to meet it; while the crest of the Monongahela, reaching Pittsburgh later, keeps up a high stage, but rarely causes the maximum. In fact, an analysis of the principal Pittsburgh floods for a number of years shows that, unless the Monongahela is at very high stage and the Allegheny at a relatively low flood stage, the crest of the former never arrives at Pittsburgh until after peak time. It is also true that whenever the Monongahela is at high stage and arrives at Pittsburgh at or before peak time, if there is a rise of any consequence in the Allegheny, a considerable flood always results.

For example, the greatest flood of the Monongahela, that of July 11, 1888, was accompanied by no rise in the Allegheny, and a Pittsburgh stage of only 22.0 feet resulted. Again, in March, 1907, the Monongahela was very high, and the Allegheny, although in flood, considerably below previous maximum. The Monongahela crest arrived at Pittsburgh several hours before peak time, while the Allegheny maximum arrived nearly 15 hours later. Likewise, in March, 1902, and in February, 1908, the Monongahela crest reached Pittsburgh at or a little before peak time, and high floods resulted.

Any discussion of the relation of the two main rivers to Pittsburgh floods is incomplete without special mention of the two principal tributaries, the Kiskiminetas and Youghiogheny Rivers. These two streams, each entering one of the main rivers from

the east, a short distance above the mouth, drain extensively deforested areas of about the same size, with heavy precipitation and a high rate of run-off; and in consequence, both collect and move their flood waters to Pittsburgh in about the same time. As a result, one or both of these streams have been important factors in every great flood that has visited Pittsburgh.

CHAPTER IV.

FLOOD DAMAGE

Pittsburgh — Physical Features — Developments — Encroachments — Investigations of Flood Damage — Profile of 1907 Flood — Details and Character of Flood Damage at Pittsburgh — Flood Damage along Rivers above Pittsburgh—Flood Damage along the Ohio River.

PITTSBURGH.

PHYSICAL FEATURES.

Pittsburgh is located 100 miles south of the Great Lakes and 300 miles west of the Atlantic Ocean, at the head of the Ohio River and on a direct line to the west from the great harbors of the east. This position has caused it to be called the "Gateway to the West". Nature has favored the locality with vast natural resources, including the most needful minerals, and waterways for transportation; and at the same time has so formed the topography, by its lines of drainage and high bordering hills, that the enormous industrial and general business activity has of necessity been concentrated along the valleys. This concentrated condition of the various interests, while it has certain disadvantages, has resulted in expediting and making more effective the daily transactions of business. The general combination of these conditions of location, topography and resources makes Pittsburgh unique and probably different from any other city in the world.

The character of the valleys for a considerable distance above and below the city is much the same as within the city limits. The hillsides in some places have slopes of about 40 degrees and rise to heights of about 450 feet above the river surface, which, at the Point, or junction of the Allegheny and Monongahela Rivers, is 703 feet above tide. The flat land in the city, which has an aggregate length of about 24 miles and an area of nearly 3,000 acres, extends from the bottom of these slopes to the river, with an average width, on either side, of about 950 feet, at a height ranging from 19 to 45 feet above pools. The elevation of the many hilltops surrounding the city ranges from about 1,000 feet to 1,250 feet, the highest being 1,370 feet, situated 3.7 miles north of the Point. The total length of river entirely within the city is 10.2 miles and the total river frontage is 31.5 miles.

DEVELOPMENTS.

The city had its beginning upon the point of land between the Allegheny and Monongahela Rivers, which location the early pioneers saw was the most strategic and favorable for all purposes. This small triangle of about 205 acres of flat ground, which extends upstream about one mile on each river, forms the heart of the business section of the present city. The original settlement, as time went on, spread along the low land bordering the rivers and nearby tributaries, and eventually mounted the hill slopes and occupied the tableland above. The reproduction of the relief map, (see frontispiece), brings out the general topographical features and indicates the extent of the developments. The city now covers an area of 26,464 acres, and has a population of 533,905. Taking into consideration the Greater Pittsburgh, which would be formed by including closely located communities, the total population would reach over 1,000,000.

Over 50 per cent of the 3,000 acres of low land bordering the rivers within the city

Flood of March 15, 1907.
Allegheny River, looking west from P. F. W. & C. Ry. bridge.

Flood of March 15, 1907.
Robinson Street, N. S., looking west from P. F. W. & C. Ry.

Flood of March 15, 1907.
Ninth Street, looking north from Penn Avenue. Deposit left by high water.

Flood of March 15, 1907.
Penn Avenue, looking east from Fifth Street.

limits was covered by water during the great flood of March, 1907. The greater part of this low ground is now used for the business life of the city, while a considerable portion is covered with steel and other manufacturing plants, which are generally located along the river banks. In the aggregate, about 15 miles of river-front land within the city limits are occupied by industrial works of various kinds, while within the so-called Pittsburgh District, or territory included by a radius of 40 miles, a total of about 27 miles is used for similar purposes.

To handle the enormous business of these numerous plants, the railroads have established a vast net-work of tracks along the river bottoms. In addition to other railroads of minor importance, five trunk lines enter the city by way of the valleys, where they are located along the low land bordering the rivers, in many places immediately along the top of the bank. In 1910, the railroad tonnage of Pittsburgh, incoming and outgoing, amounted to 156,000,000 tons, and the river traffic to about 11,000,000 tons. The present total tonnage, 167,000,000 tons, which has doubled in the last six years, is twice as great as the combined tonnage of New York, London, Hamburg and Marseilles.

About 14,000 miles of inland waterways are directly connected with the city. Over 150 miles of the rivers above Pittsburgh, as well as portions of the Ohio, have been improved; and it is the purpose of the National Government to continue this improvement along the entire Ohio River, so that this stream will be slackwatered by the end of about ten years. The harbor proper, which has a navigable depth of 10 feet and over, created by Davis Island dam, five miles below the Point, extends pool into the Allegheny River, 1.6 miles, to Lock No. 1, and into the Monongahela River, 1.9 miles, to Lock No. 1, of that stream. The average width of the rivers in this harbor at pool surface is as follows: Ohio, 1,385 feet; Allegheny, 770 feet; Monongahela, 850 feet. The total water surface has an area of about 1.8 square miles.

ENCROACHMENTS.

These activities of man have brought about extensive encroachments upon the rivers, in the placing of which the absolute requirements of nature have been thoughtlessly ignored and little consideration given to the disastrous results which must inevitably follow continuance of the process. This short-sighted policy, endangering the broad public interests of the present as well as of the future, was continued without limit or control until 1895, when harbor lines were established by the National Government. The State of Pennsylvania, under an act passed in 1907, has likewise had jurisdiction over the placing of obstructions in or along the streams of the state.

Allegheny River.

According to the maps prepared by the Pennsylvania River Commission for Pittsburgh and vicinity, in the year 1861, the average width of the Allegheny River for a distance of 7 miles from its mouth was 1,250 feet. It is thought that when this map was made, the river was very nearly in its original state. By measurements made on the map of the Flood Commission, of 1910, it has been ascertained that the river channel, between the top of banks, now has an average width of 1,040 feet, which shows a contraction of 210 feet, or 17 per cent. In comparing this stretch of the river with the portion lying between the lower seven miles and the mouth of the Kiskiminetas River, 23 miles above, it is seen from a map made in 1875 that this upper part then had an average width of about 1,380 feet, or 130 feet greater than in 1910.

Along the right bank and near the mouth of the Allegheny, Killbuck Island, which in 1858 was a low bar something over half a mile long, has since been filled over. At Twenty-third Street, 1.7 miles above the mouth, the total encroachment, including both sides of the river, is about 300 feet. At Wainwright Island, a low island about one-half mile long, formerly situated at the left bank, 2.7 miles above the mouth, or with its lower end opposite what is now Thirty-third Street, the back channel has been entirely filled in. The total encroachment at the foot of the island is estimated to be about 400 feet, practically all of which is at the left bank. At a point about 2.4 miles above the mouth, the width, between top of banks, has been diminished about 35 per cent.

The narrowest part of the river in the vicinity of Pittsburgh occurs about 3.9 miles from the mouth, a short distance below Fifty-first Street. At this point the distance between bank lines for a stretch of several hundred feet is only about 690 feet. It is believed that this short reach has always been abnormally narrow, the width in 1858 being only about 910 feet. Nature, however, has to some extent succeeded in remedying this contraction by scouring out the channel to a depth ranging from 22 to 26 feet.

Monongahela River.

In 1861, the average width of the Monongahela between top of banks, for a distance of 4 miles above the mouth, as shown on the map of the Pennsylvania River Commission, was 1,320 feet. Comparing this with the present conditions, as shown on the map of the Flood Commission, it is determined that the amount of encroachment averages about 390 feet, showing an average contraction of 30 per cent. From the Point to the Smithfield Street bridge, a distance of 0.8 mile, the average width of encroachment since 1858 is about 310 feet, and the maximum 550 feet. From Smithfield Street bridge to Lock No. 1, about one mile above, the reduction in width averages about 450 feet, with a maximum of 590 feet at Seventh Street, South Side. Along these reaches the greater part of the filling was made on the left bank. Above the lock, to Thirty-fourth Street, South Side, the encroachment, totaling both sides of the river, ranges from 300 feet to 600 feet, the maximum occurring a few hundred feet below the Monongahela Connecting Railroad bridge. About 3 miles above the mouth of the river, the width between banks has been reduced nearly 40 per cent.

Bridges and Navigation Dams.

The cross-section of the present river channels is also contracted at a number of points by the approaches, piers and riprapping of bridges, and by the navigation dams. In the Allegheny River channel, for example, this reduction of area of cross-section amounts, at the elevation of the 1907 flood, to about 9 per cent at the Sixth Street bridge and about 15 per cent at Herr Island dam, considering only the fixed part of the lock and dam. On the Monongahela River, this contraction of channel cross-section is about 10 per cent at the Smithfield Street bridge and 12 per cent at Dam No. 1. At Davis Island dam, the cross-sectional area above the fixed parts is greater than the cross-section of the river channel at other points nearby.

INVESTIGATIONS OF FLOOD DAMAGE.

Although Pittsburgh and many other communities along the streams above and below the city have suffered from floods for a century or more, nothing in the way of ascertaining the extent of the damage or of formulating a plan for relief was undertaken until after the great flood of 1907. The enormous destruction of property and the

Flood of March 15, 1907.
Federal Street, N. S., looking south from Lacock Street.

Flood of March 15, 1907.
Sixth Street, looking north from Liberty Avenue.

general distress caused by this flood, together with the knowledge that records indicated that the floods were increasing in frequency, caused an investigation to be made for the purpose of determining the extent and character of the frequently occurring floods and resultant damage and, if possible, devising means for relief.

PRELIMINARY INVESTIGATIONS.

The first work, conducted by the flood committee referred to under "History and Objects of Commission," was to ascertain the extent of the damage within the City of Pittsburgh. In the investigations made for this purpose, considerable difficulty was at first encountered in getting the facts as to actual flood losses. While those coming in direct contact with the flood troubles are alert to the seriousness of the situation during the floods, the matter is, after a time, almost forgotten, the disposition in most cases apparently being to take the troubles as they come, rather than to do anything in the way of even attempting to devise means of relief. Finally, however, through a large amount of correspondence and a canvass of much of the flood-affected districts, the committee succeeded in preparing a provisional report showing the vast extent of the damage and the great need that something should be done for the protection of the important interests lying along the rivers.

Methods.

Particular attention was given in the investigations to the three recent floods, occurring within a period of twelve months and five days, namely, those of March 15, 1907, February 16, 1908, and March 20, 1908. The respective heights of these floods were 35.5 feet, 30.7 feet and 27.3 feet. The work was conducted under the following classifications: (a) Damage to buildings, equipment and machinery; (b) Damage to materials; (c) Loss to employer by suspension of business; (d) Loss to employees due to shut-down; (e) Expense of cleaning-up.

Findings.

This first work brought out the fact that, unless means for flood control could be accomplished, the larger portion of the affected area could never be properly developed, and the capital invested therein would continue to suffer. It also showed that, since the general needs of building operations and city improvement will of necessity keep pace with the advance of population, the flood damages, which, in their effect, involve the home conditions and business of the entire city, will become correspondingly greater. As stated above, by far the larger part of the mercantile, industrial and railroad interests of Pittsburgh have necessarily been developed along the rivers, upon the favorably situated low-level areas. As computed in the preliminary work, nearly 1600 acres of this important district were covered by the flood of 1907, while a considerable additional area was affected by seepage and backwater from the sewers. The assessed valuation of the real estate thus affected by overflow amounts to about $160,000,000, and a careful estimate, made in consultation with real estate experts, shows that this property is nearly $50,000,000 lower in value than it would be if protected from floods.

FINAL INVESTIGATIONS.

Methods.

The above investigations, as stated, were carried on by the flood committee. Upon proceeding with the work, the Commission was enabled to arrive at results of the de-

of the desired accuracy, by means of further research, and by the surveying and mapping of the rivers and the areas affected by floods, within the city. These areas were districted in accordance with the character of the business, and the direct losses of the various interests have been conservatively estimated, for each of the three floods mentioned above.

Findings.

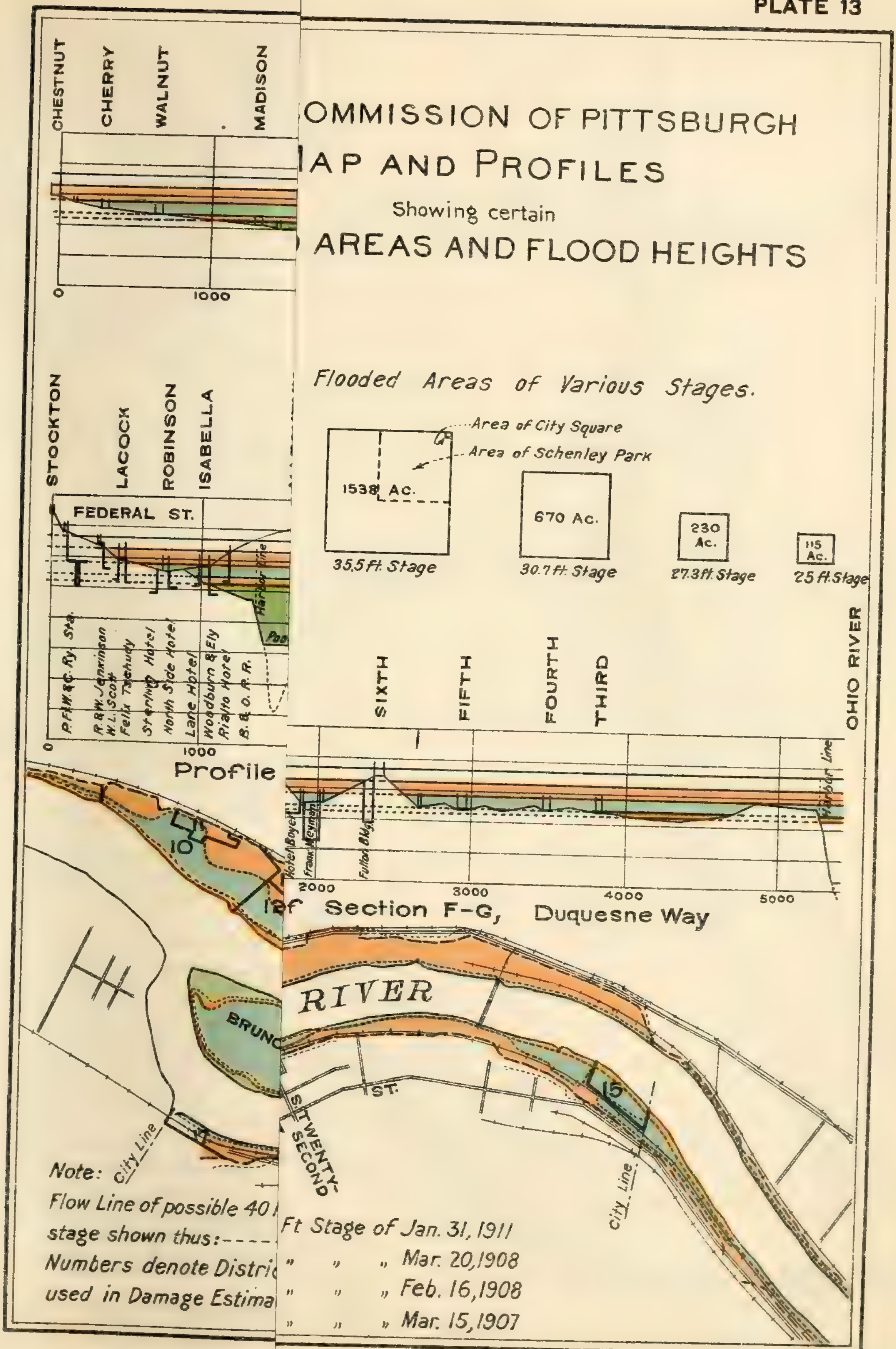
The following table, giving the results of these investigations, shows that the total direct loss for three floods amounted to $6,514,000, and that the loss ranges from $414,700 for the flood of 27.3 feet to $5,259,500 for the one of 35.5 feet. In this report, all estimates as to damage from other floods have been based upon the investigations for this period, from March 15, 1907, to March 20, 1908. In the past twenty years, the losses due to flood damage at the City of Pittsburgh alone have amounted to about $17,000,000, over $12,000,000 of which occurred in the ten years preceding January, 1911.

TABLE No. 28.

DIRECT LOSSES BY THREE FLOODS IN PITTSBURGH.

Classification	Date of flood	Damage to buildings, equipment and machinery (a)	Damage to materials (b)	Loss to employer by suspension of business (c)	Loss to employees due to shut-down (d)	Expense of cleaning-up (e)	Charities dispensed and funds for prevention of disease (f)	Fires uncontrolled through inaccessibility or lack of water pressure (g)	Total
Heavy Industrial	March 15, 1907	$180,100	$159,400	$365,400	$693,700	$79,200	------	-------	$1,477,800
	February 16, 1908	30,900	10,300	33,500	138,800	16,400	------	-------	229,900
	March 20, 1908	15,000	4,800	18,900	120,500	11,300	------	-------	170,500
	Total	226,000	174,500	417,800	953,000	106,900	------	-------	1,878,200
Lesser Industrial	March 15, 1907	50,800	320,600	82,000	58,300	62,100	------	-------	573,800
	February 16, 1908	5,500	12,500	22,300	7,000	19,900	------	-------	67,200
	March 20, 1908	3,600	5,000	7,900	4,300	6,500	------	-------	27,300
	Total	59,900	338,100	112,200	69,600	88,500	------	-------	668,300
Heavy Mercantile	March 15, 1907	186,000	706,800	867,700	137,200	108,800	------	-------	2,006,500
	February 16, 1908	15,000	19,200	189,700	68,400	22,900	------	-------	315,200
	March 20, 1908	10,100	4,500	72,500	17,300	14,000	------	-------	118,400
	Total	211,100	730,500	1,129,900	222,900	145,700	------	-------	2,440,100
Lesser Mercantile and Dwellings	March 15, 1907	105,700	312,100	166,600	25,700	79,200	------	-------	689,300
	February 16, 1908	11,900	68,100	15,900	8,400	26,200	------	-------	130,500
	March 20, 1908	9,700	7,700	11,800	5,700	16,800	------	-------	51,700
	Total	127,300	387,900	194,300	39,800	122,200	------	-------	871,500
Transportation, Steam Railroads	March 15, 1907	9,700	28,200	60,000	7,300	24,200	------	-------	129,400
	February 16, 1908	1,800	300	----	600	6,900	------	-------	9,600
	March 20, 1908	1,600	100	------	200	1,900	------	-------	3,800
	Total	13,100	28,600	60,000	8,100	33,000	------	-------	142,800
Transportation, Electric Railroads	March 15, 1907	7,000	600	11,000	8,000	6,000	------	-------	32,600
	February 16, 1908	1,000	300	3,200	500	3,900	------	-------	8,900
	March 20, 1908	-----	200	200	300	2,600	------	-------	3,300
	Total	8,000	1,100	14,400	8,800	12,500	------	-------	44,800
Navigation	March 15, 1907	34,100	6,200	15,100	2,400	1,000	------	-------	58,800
	February 16, 1908	8,500	1,600	6,200	1,700	800	------	-------	18,800
	March 20, 1908	1,500	900	4,000	700	400	------	-------	7,500
	Total	44,100	8,700	25,300	4,800	2,200	------	-------	85,100
Interests not Classified	March 15, 1907	42,900	11,700	10,600	500	6,100	------	-------	71,800
	February 16, 1908	21,700	1,000	9,000	800	2,500	------	-------	35,000
	March 20, 1908	4,100	1,000	700	------	2,100	------	-------	7,900
	Total	68,700	13,700	20,300	1,300	10,700	------	-------	114,700
City Departments	March 15, 1907	12,200	5,800	------	------	16,800	9,700	175,000	219,500
	February 16, 1908	6,000	5,000	------	------	4,500	9,200	-------	24,700
	March 20, 1908	6,000	5,000	------	------	4,400	8,900	-------	24,300
	Total	24,200	15,800	------	------	25,700	27,800	175,000	268,500
Summary	March 15, 1907	628,500	1,551,400	1,578,400	933,100	383,400	9,700	175,000	5,259,500
	February 16, 1908	102,300	118,300	279,800	226,200	104,000	9,200	-------	839,800
	March 20, 1908	51,600	29,200	116,000	149,000	60,000	8,900	-------	414,700
	Total	$782,400	$1,698,900	$1,974,200	$1,308,300	$547,400	$27,800	$175,000	$6,514,000

PLATE 13



Numbers 2,
Numbers 1
Numbers 3

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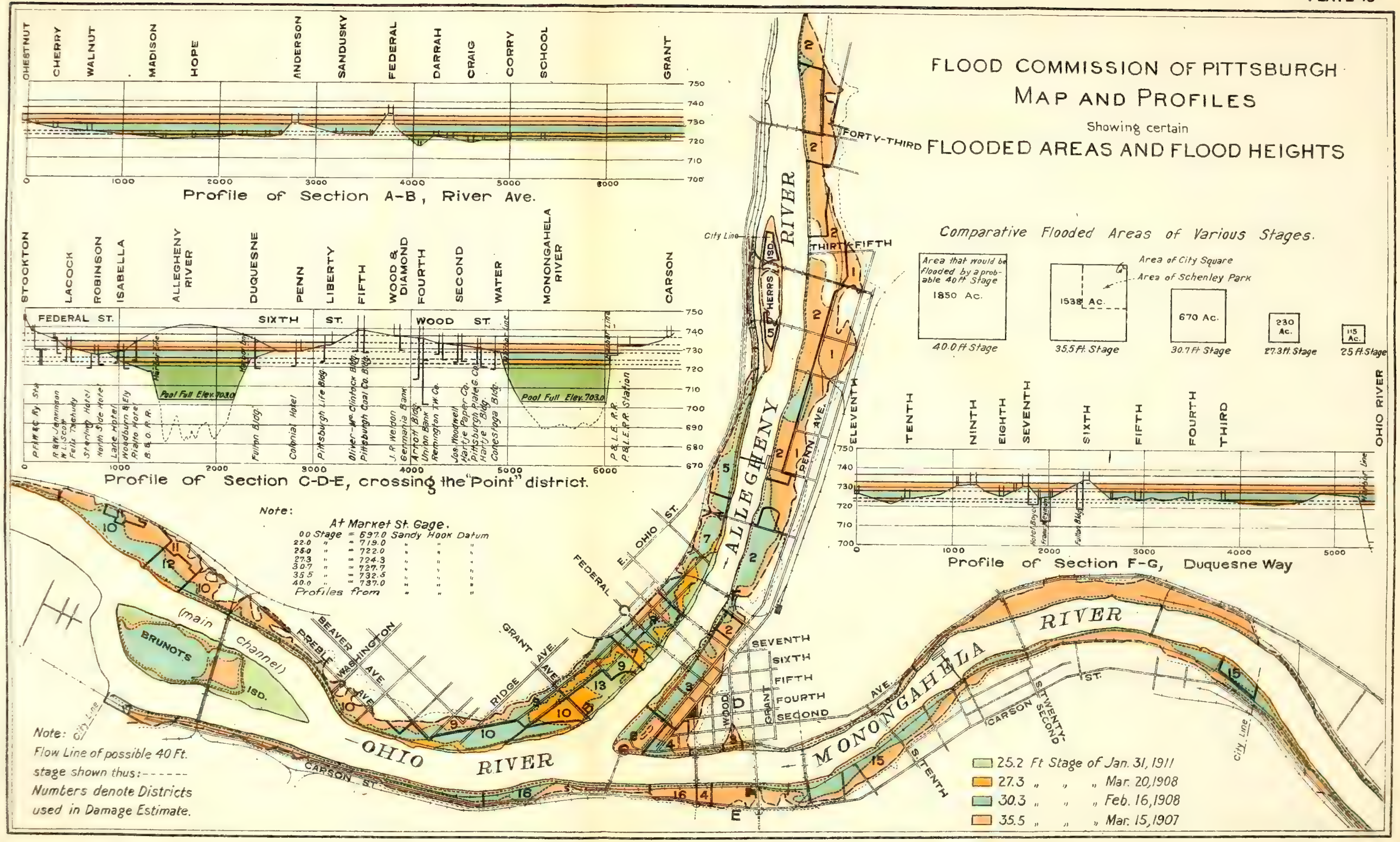


Numbers 2, 5, 10, 14, 15 and 16 are Heavy Industrial Districts.
Numbers 1 and 9 are Lesser Industrial Districts.
Numbers 3 and 8 are Heavy Mercantile Districts.
Numbers 4, 7, 11 and 17 are Lesser Mercantile Districts.
Numbers 6, 12 and 13 are Unclassified Interests.

Based on the assumption that in the next two ten-year periods there will be no increase in the number or height of floods over those occurring in the ten years just preceding January, 1911, it is estimated that the flood losses at Pittsburgh in the next twenty years will amount to about $25,000,000. As mentioned elsewhere in this report, however, the records show that the floods are increasing in frequency and height, and if this is taken into account, it is estimated that the losses in the next twenty years will amount to about $40,000,000. Moreover, even neglecting this increasing tendency, the fact that developments within the flood-affected district are yearly exposing additional property to flood damage will obviously result in a perceptible increase in flood losses.

Difficulties were encountered in getting reliable data concerning "Damage to buildings," column (a), and for items under (c) and (d), shown in the above table, but it is thought that these, as well as most of the other items, are underestimated.

Important features regarding extent of overflow by various floods are as follows:

Flood of March 15, 1907. Gage height, 35.5 feet.

Total land area submerged (maximum depth 16 feet)	1540	acres
Industrial district, including 13 acres of Herr Island and all of Brunot Island, 157 acres	866	"
Mercantile and residential	192	"
Railroad and industrial yards	435	"
Other property	47	"
Main railroad tracks (maximum depth 16 feet)	17	miles
Street car tracks " " 12 "	8.7	"
Streets and alleys " " 14 "	33.4	"

During this flood the water was 16 feet deep over the Baltimore & Ohio tracks on the North Side, while the tracks at the Pittsburgh & Lake Erie station, on the left bank of the Monongahela River, were covered to a depth of 6 feet. At the crest of the flood, in addition to the 17 miles of main railroad track above mentioned, a number of important sidings and yards were covered for a considerable part to a depth of from 2 to 16 feet.

Flood of February 16, 1908. Gage height, 30.7 feet.

Total land area submerged (maximum depth 11 feet)	670	acres
Industrial district, including part of Brunot Island, 136 acres	451	"
Mercantile and residential	116	"
Railroad and industrial yards	81	"
Other property	22	"
Main railroad tracks (maximum depth 11 feet)	8.2	miles
Street car tracks " " 7 "	4.8	"
Streets and alleys " " 9 "	16.3	"

Flood of March 20, 1908. Gage height, 27.3 feet.

Total land area submerged (maximum depth 8 feet)	230	acres
Industrial district, including part of Brunot Island, 70 acres	140	"
Mercantile and residential	48	"
Railroad and industrial yards	37	"
Other property	5	"
Main railroad tracks (maximum depth 8 feet)	1.4	miles
Street car tracks " " 4 "	1.3	"
Streets and alleys " " 6 "	6.3	"

40-Foot Stage. As shown in the preceding chapter, it is not improbable that Pittsburgh will some day experience a forty-foot flood. The extent of the overflow at this stage would be as follows:

Total land area submerged	1850	acres
Main railroad tracks submerged	23	miles
Street car tracks submerged	13	"
Streets and alleys submerged	45	"

25-Foot Stage. At a stage of 25 feet, 115 acres are overflowed, involving a mileage as follows: railroad tracks, 1.15; street car tracks, 0.55; streets and alleys, 1.5.

22-Foot Stage. A stage of 22 feet has always been considered as the danger point, or stage at which damage first occurs. It is found, however, that at this stage, on the right bank of the Allegheny, or North Side* of the city, about 10 acres of land are covered, one railroad station involved, that of the Baltimore & Ohio Railroad, and nearly one mile of main track, not including sidings, together with other interests.

Stages below 22 Feet. At stages below 22 feet, numerous cellars and basements of many office buildings and stores are affected by seepage or by backwater through sewers, and pumping is frequently resorted to. The platform and tracks at the Baltimore & Ohio station on the North Side are covered at a stage of 20 feet.

To show the condition prevailing over a considerable part of the industrial district, relative to damage or inconvenience resulting from various stages, the following table has been compiled from elevations obtained at 53 of the larger industrial plants along the Allegheny, Monongahela and Ohio Rivers, within the area affected by floods in the City of Pittsburgh. At the lower stages the plants are first affected by water entering wheel or boiler pits, by seepage or otherwise.

TABLE No. 29.

NUMBER OF INDUSTRIAL PLANTS AFFECTED AT VARIOUS STAGES.

Stages	Partially Affected* By intervals	Partially Affected* Total	Shut Down† By intervals	Shut Down† Total
16.5 to 18	2	2	1	1
18 " 20	1	3	0	1
20 " 22	7	10	1	2
22 " 24	8	18	1	3
24 " 26	10	28	6	9
26 " 28	14	42	7	16
28 " 30	2	44	8	24
30 " 32	2	46	6	30
32 " 34	6	52	4	34
34 " 35.5	1	53	11	45

*Lowest stage at which plants are affected, 16.5 feet.
†Lowest stage at which plants are shut down, 17.0 feet.

The flood stages are based on the zero of the Market Street gage, which has an elevation of 696.8 feet above mean tide. About 19 per cent of the 53 plants investigated are affected between the stages of 16.5 feet and 22 feet, while between 16.5 feet and 30 feet, 83 per cent are affected and 45 per cent shut down. The following table shows the duration of the three floods above certain stages.

TABLE No. 30.

DURATION OF FLOODS.

March 15, 1907 Stage (Feet)	March 15, 1907 Time (Hours)	Feb. 16, 1908 Stage (Feet)	Feb. 16, 1908 Time (Hours)	March 20, 1908 Stage (Feet)	March 20, 1908 Time (Hours)
22	65	22	52	22	33
26	49	26	32	26	18
30	33	30	10	27.3	4
35	4	30.7	3		
35.5	1				

Profile of 1907 Flood.

At the time the city surveys of the Flood Commission were made, in the summer of 1909, the flood lines of the March 15, 1907, flood were carefully run along both sides of the river, 328 high-water marks being used for this purpose. Of these marks, 239 were located by the Flood Commission, 44 were obtained from the U. S. Engineer, 25 from the Pittsburgh & Lake Erie Railroad and 20 from various other sources.

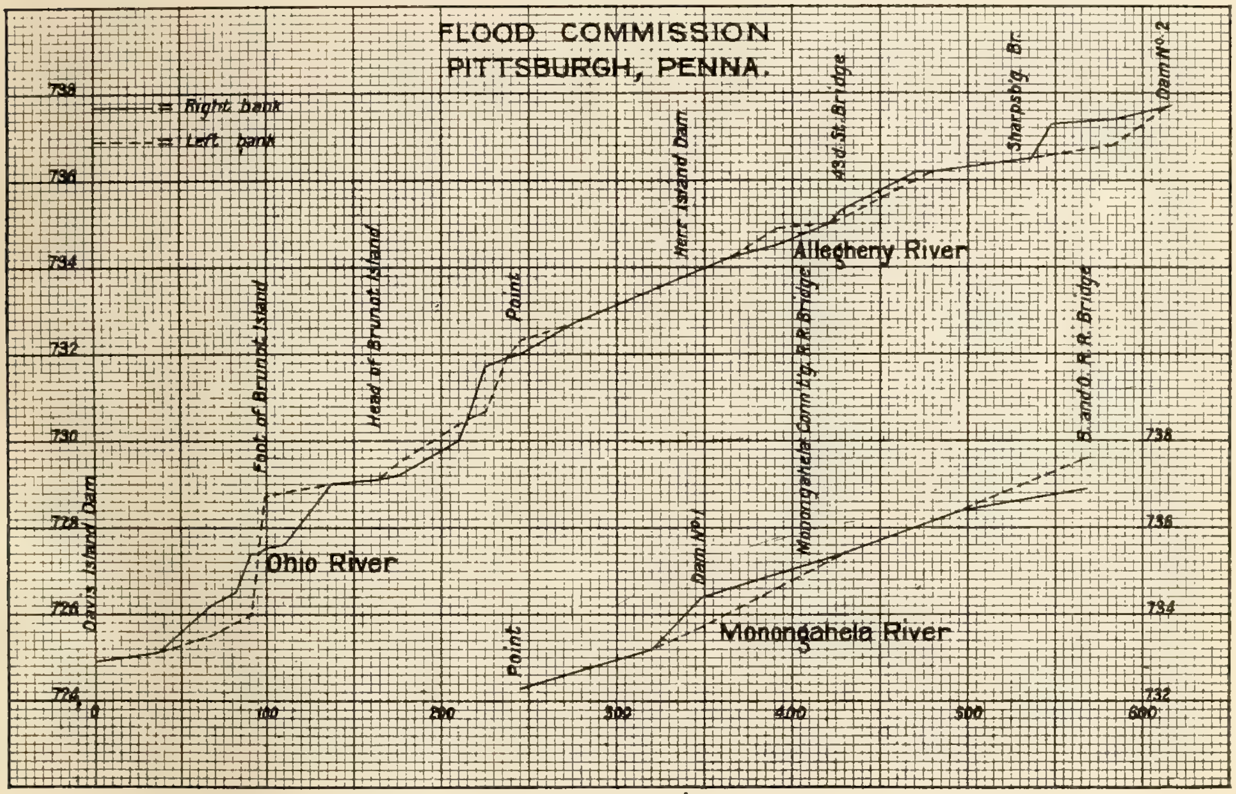
*Originally City of Allegheny. Annexed to Pittsburgh, December, 1907.

Flood of March 15, 1907.
One of the large manufacturing plants.

Flood of March 15, 1907.
Plant of the Allegheny County Light Co.

From these marks was constructed a profile of the flood lines along each bank, which brought out the fact that the elevation of the flood crests at various points along the three rivers is frequently different on opposite banks. This difference is caused by bends and obstructions in the channels, and, near the Point, by the varying effect of the Allegheny and Monongahela Rivers upon each other at their junction. At the crest of the flood of March 15, 1907, this difference of elevation of flood lines was very marked, and the principal peculiarities may be noted from the accompanying profile.

PLATE 14



Profile of flood, March 15, 1907, showing difference in elevation on opposite banks.

The profiles of the 1907 flood shown elsewhere in this report are based on the average of the flood line elevations on opposite banks. The total fall of this average flood line between Dam No. 2, Allegheny, and the Point, a distance of 6.96 miles, is 5.5 feet, or 0.79 foot per mile; between the Glenwood highway bridge, on the Monongahela, and the Point, a distance of 5.97 miles, is 4.9 feet, or 0.82 foot per mile; between the Point and Davis Island dam, a distance of 4.68 miles, is 7.3 feet, or 1.56 feet per mile; a total fall of 12.8 feet in the 11.64 miles between Dam No. 2, Allegheny, and the Davis Island dam.

Details and Character of Flood Damage at Pittsburgh.

From the accounts which follow, some idea may be formed of the dangers, losses and serious inconvenience experienced in the flood district.

The entire city was in imminent danger of being without water supply during the flood of 1907. The elevation of the flood crest at Brilliant pumping station was 42.1; the door sills of the boiler rooms are at 41.3. In two of the buildings in which the fires were at or below the flood level, the water was kept out by bulkheads at the doors. In one other building, having inclined grates under the boilers, the water was just at the bottom of

the grates; and in another building, having similar fires, the water was up 6 inches upon inclined grates, showing that the fire was burning in about two-thirds of the grates. It is commonly believed that the continuance of the flood a few hours longer, or a rise of even 6 inches, might have overcome the simple temporary barriers that were raised at the doors and thus have shut down the pumping station supplying the whole of the old City of Pittsburgh. A private water company, furnishing water to a considerable area of the south side of the city, was totally incapacitated during the flood of 1907, and for over a week the plant was out of use.

Many connections with the fire alarm and police control boxes were broken, and the cost to the Bureau of Electricity for removal of wires and replacing of same amounted to nearly $50,000 for the three floods. Property destroyed by fire at the time of the 1907 flood, due to inaccessibility of buildings or reduced head in water mains, amounted to about $175,000.

About 600 poor families received assistance from the Department of Charities on account of the effects of the 1907 flood, and nearly as many were aided at the time of the two succeeding floods of 1908. A considerable expenditure for disinfection and general sanitary work was necessary after these floods.

Of approximately 105 office buildings in Pittsburgh, about 35 were affected by the flood of 1907 and 15 by the flood of February, 1908. In some of these buildings, during the 1907 flood, the elevators had to discontinue service, in a few cases for a period of one week, and it is estimated that at least 50,000 people were put to inconvenience thereby.

Of the 205 acres of low-level land forming the Point district and occupied by the chief business interests of the city, 107 acres or 52 per cent were overflowed during the 1907 flood. A 40-foot flood would inundate 139 acres or 68 per cent of this district.

The approaches of seven of the principal city bridges were surrounded by water at the time of the 1907 flood. All vehicle travel was cut off between Allegheny and Pittsburgh. Duquesne Way, which is located along the left bank of the Allegheny River, in the heart of the business section of the city, was covered for a distance of about seven blocks to a depth of from 6 to 9 feet; and River Avenue, paralleling the opposite bank, was covered for a distance of about nine blocks to a depth of from 9 to 14 feet. Street car service stops where the depth of water is 6 inches or over. Passengers were hauled by the P., F. W. & C. Ry. The cutting-off of communication on some of the lines of transportation is a matter which affects not only the flood district, but the whole city, and in fact its influence extends outside the county lines.

It has frequently been necessary, at time of high stages, for many manufacturing plants to close down, and the following, quoted from a report of the American Iron & Steel Association, is noteworthy.

"Damage to the iron and steel industry unprecedented. At beginning of March, 1907 flood, there were 44 blast furnaces in Allegheny County in blast, and of these, 38 had to be banked for an average of two days. Work at most of the 65 or 70 rolling mills and steel works was suspended."

Twelve of the above furnaces, located within the city limits of Pittsburgh, were closed down. Many open-hearth furnaces were badly damaged, and some of them practically ruined.

One of the great interruptions to business is the necessity of moving materials to higher levels, and with this, the expense of handling. In many cases it is impossible to move the material, even if there is time for so doing, and a partial or total loss results. In this connection it should be mentioned that the Weather Bureau renders valuable service in giving notice of the approach of floods and an estimate as to the probable height.

Flood of March 15, 1907.
Pittsburgh & Lake Erie Railroad Station.

Flood of March 15, 1907.
Railroad yard, looking east from south end of Smithfield Street bridge.

This service frequently prevents losses and sometimes the necessity of moving materials.

The flood menace is so discouraging to the occupants of many localities, that cellars are often not used, except for storage of articles of small value, or putting away of refuse. Hundreds of cellars, as well as other parts of the buildings, have consequently been found in bad sanitary condition. A large reinforced-concrete storage house, recently constructed in the flooded district, under present conditions makes no use of its basement floor, except for unloading from cars to elevators. It is stated that, if the possibility of this ground floor being flooded were removed, the owners would use the greater part of this valuable space for storage purposes and thus increase the value of this building 20 per cent or more.

The interference with certain low-lying railroad properties has been referred to elsewhere in this chapter, and it may be said, for a considerable part of these developments, that any material change in the way of elevating the tracks is practically impossible.

Flood Damage along Rivers above Pittsburgh.

No estimate has been obtained regarding the flood losses of communities situated along the rivers above Pittsburgh, though it is known that many are seriously affected, the property loss being frequently very considerable. Railroad wash-outs and destruction to works along these lines are of frequent occurrence. Buildings and river craft are often torn loose by the swift current and swept away, frequently with disastrous results to moored boats, bridges and piers.

Flood Damage along the Ohio River.

The following is taken from a letter received from the Board of Trade of Wheeling, W. Va. This city is located 90 miles below Pittsburgh, and this report serves to show the damage which occurs at other places of this size similarly situated.

"The most disastrous flood in recent years was that of 1907, and I should say that the Wheeling district sustained losses, at a conservative figure, of upwards of $1,000,000. The sum includes the stoppage of a payroll which is estimated at our mills and factories here at $100,000 a day, the paralysis of railroad and street car traffic, and the general suspension of business, and damage inflicted on 2,000 or more houses in the flood sections, amounting to from $20 to $100 each.

"Lesser floods inflicted damages proportionally and they have proven very costly to manufacturers, railroads and property owners generally."

Concerning the effects of the floods along the Ohio River, the following is given from the report of the Inland Waterways Commission, issued in 1910.

"An estimate of the damage caused by the January and March floods of 1907, compiled from local reports along the valley, amounted to more than $100,000,000. This estimate included destruction of real and personal property and interruption of trade, but did not include depreciation. This is the most serious of all flood losses."

CHAPTER V.

METHODS OF FLOOD RELIEF.

Introduction—Flood Protection—Flood Prevention—Reforestation—Storage Reservoirs—Combination of Protection and Prevention.

INTRODUCTION.

The appalling amount of and evident increase in the flood damages makes the study and solution of the flood problem an important factor in the prosperity and proper development of Pittsburgh and of the communities bordering the rivers above and below the city. There are a number of ways in which inundation may be prevented in any low-lying district along a river, and the best selection or combination of one or several of these is generally a matter of considerable study and expert judgment, the best solution of the problem varying of necessity with the respective local conditions. The methods of dealing with the problem may be divided into two general classes, Flood Protection and Flood Prevention.

FLOOD PROTECTION.

Flood Protection would deal with the floods directly at the points of overflow and damage, and would attempt, not to reduce the flood discharge, but to prevent overflow. In other words, the floods would still occur, but would do no damage by overflow, because they would be confined to the river channels by suitable works.

The protective measures might consist of the elevation of territory subject to inundation or of the construction of walls, or of both. These means of protection might be supplemented by straightening, widening and dredging of the river channels, and by the removal of obstructions, all of which would tend to cause floods to discharge at lower stages. If the topographical conditions were not so unfavorable, it might have been possible at Pittsburgh to further reduce flood levels by means of one or more diversion channels to relieve the rivers of part of their flood flow.

Obviously, if one or several of the above protective measures were employed at Pittsburgh, the benefits of flood relief would be local only, and the floods above might be made worse by backwater caused by walls restricting the channel. The communities along the rivers above and below Pittsburgh, should they desire similar relief, would have to work out their own salvation through similar local methods of flood protection. Moreover, as there would be no considerable lowering of the flood levels, the trouble experienced by the navigation interests, owing to high velocities in the rivers, to insufficient clearances under the bridges and to wide fluctuations in water levels during floods, would continue.

It is also true that flood relief would be the only benefit to be obtained by this method, for there would be no increase in the low-water flow of the rivers and their tributaries, and hence no benefits to navigation and no improvement in the quality of water for domestic and industrial supply.

FLOOD PREVENTION.

Flood Prevention would deal with the floods at their sources, and by holding back the damaging part of the flood water, would lower the crests of the floods to below the danger line. In other words, it would prevent the occurrence of floods and partly or wholly remove the necessity of works for Flood Protection.

REFORESTATION.

Flood Prevention can, to some extent, be effected by retarding the run-off by reforestation, and it is generally believed that a certain amount of improvement in low-water flow can also be obtained by this means. It is probable also that increase in the frequency and height of floods could be prevented and a better maintenance of the low-water flow obtained through preservation of the forest areas that even now exist. For these reasons the attitude of the Flood Commission with regard to this means of Flood Prevention is to recommend and support such National and State legislation as will tend to preserve and increase the present forest cover.

Reforestation, however, is a slow process, and the partial flood prevention that can be obtained by this means would not give immediate relief. A more prompt and complete solution of the flood problem is necessary.

STORAGE RESERVOIRS.

The damaging flood waters can be entirely held back by means of storage reservoirs on the various tributaries above Pittsburgh. The Flood Commission has made extensive surveys and studies which determine the location, the cost and the effect upon floods of such reservoirs.

The use of storage reservoirs for flood prevention is not an experiment. This method has been successfully employed and its effectiveness actually demonstrated in European countries to an extent that has led to the adoption of numerous additional reservoir projects now planned or under construction for this purpose, as is fully described in another part of this report.

Nor is this means of flood relief for Pittsburgh a new idea. During the past sixty years the prevention of floods at Pittsburgh and along the Ohio Valley by means of storage reservoirs has been written upon and discussed by a number of eminent engineers, and the nearly unanimous opinion has been that floods could be prevented by this means. These engineers, however, have, with a few notable exceptions, expressed the opinion that the probable enormous cost of the necessary reservoirs would not be warranted by the benefits to be derived from the system. Detailed estimates based upon actual surveys of reservoir sites, on the one hand, and complete information as to the extent of the flood damage, on the other, were unfortunately not available to guide these engineers in their opinions. In the light of such complete data as the Flood Commission has obtained, however, it is possible to state positively that Pittsburgh floods can be completely controlled by storage reservoirs, and that the cost would be only about half the probable flood damage at Pittsburgh alone in the next twenty years, and only half the certain increase in the value of the Pittsburgh property that would be relieved from the flood menace.

Prevention is obviously the rational and comprehensive treatment of the flood problem, going as it does to the source of the trouble and extending its benefits throughout the entire river valleys, not only in the form of flood relief, but by the improvement of the low-water flow, due to the release of the impounded flood waters during the dry season. The ideal river is one having uniform discharge the year round, and any approach to that condition very largely adds to its usefulness.

At the outset, when the Commission entered upon its investigations with the problem in view of relieving Pittsburgh from floods, it was generally thought that the work to be done was local in character and the benefits to be derived were confined to flood relief only. As the surveys and studies progressed, and the magnitude and far-reaching character of the benefits of flood relief became evident, it was realized that not only Pittsburgh, but the entire valleys of the Allegheny, Monongahela and Ohio Rivers could

be benefited by the construction of storage reservoirs. In short, it was determined that flood relief must be looked upon, not as a local, but as a State and National problem.

It is significant to note, in this connection, the statements of the Inland Waterways Commission, in the "Findings" of its Preliminary Report, issued in 1908.

"Improvements of navigation in inland waterways in the main affect favorably the purity of the waters and the regularity of the supply, and these objects should be carefully kept in mind. The increasing pollution of streams by soil wash and other waste substances connected with a growing population reduces the value of the water for manufacturing purposes, and renders the water supply for communities injurious to and often destructive of human life. The prevention of these evils should be considered in any scheme of inland waterway improvement.

"Engineering works designed to improve navigation affect favorably the regimen of the streams, including floods and low waters. The annual floods of the United States occasion loss of property reaching many millions of dollars with considerable loss of life, while the low water of late summer involves large loss in diminished water supply, in reduced power, and in the fouling of streams with consequent disease and death. It has been claimed that in specific cases the cost of works required both to control floods and meet the needs of commerce would be less than the amount of this loss.

"The effect of wide variations in the level of navigable streams is to render difficult the establishment of necessary terminals for the handling of traffic, and thus to interfere seriously with the utilization of our inland waterways. The prevention or mitigation of such variations would be most helpful to the revival of river traffic, and means to this end should be adopted in plans for waterway improvement.

"The control of waterways on which successful navigation depends is so intimately connected with the prevention of floods and low waters, and works designed for these purposes; with the protection and reclamation of overflow lands, and works designed therefor; with the safeguarding of banks and maintenance of channels, and works employed therein; with the purification and clarification of water supply, and works designed therefor in conjunction with interstate commerce; with control and utilization of power developed in connection with works for the improvement of navigation; * * * * * * that local and special questions concerning the control of waterways should be treated as a general question of national extent, while local or special projects should be considered as parts of a comprehensive policy of waterway control in the interests of all the people.

"The benefits of a comprehensive system of waterway improvement will extend to all the people in the several sections and States of the country; and the means employed should be devised so far as possible to distribute the cost equitably through coöperation between Federal agencies, States, municipalities, communities, corporations and individuals."

In making its recommendations in the same report, the Commission states:

"We recommend that hereafter plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce, shall take account of the purification of the waters, the development of power, the control of floods, the reclamation of lands by irrigation and drainage, and all other uses of the waters or benefits to be derived from their control.

"We recommend that hereafter both local and general benefits to the people shall be fully considered in any such plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce; and that wherever practicable Federal agencies shall coöperate with States, municipalities, communities, corporations, and individuals with a view to an equitable distribution of costs and benefits."

COMBINATION OF PROTECTION AND PREVENTION.

The studies of the Flood Commission along the two lines described above have led to the conclusion that the best solution of the Pittsburgh Flood Problem lies in a combination of Flood Protection and Flood Prevention. It has been determined that enough storage can be created on the two drainage basins above Pittsburgh to reduce all floods below the danger line. But it has further been determined that the stage of the highest flood can be reduced by a somewhat less storage to a certain point, and the balance of the rise taken care of by a wall along a few low-lying portions of the river bank. The cost of this modified protection work is comparatively so small that it is far cheaper to carry it out than to construct enough storage to lower the maximum floods to a point where there would be no overflow at Pittsburgh.

Extended storage, in excess of that required in a scheme combining Protection and Prevention, would be of great additional value to navigation, water power, water supply, sanitation, etc., and later studies may show that a considerable portion or all of the storage possibilities obtained by the surveys and investigations of the Commission can be constructed to advantage. The Flood Commission, however, has confined its work to deter-

mining what is the least practical amount of construction necessary to furnish protection against floods, leaving the matter of working out the practical limits of the collateral advantages that may be obtained by enlarging the basic plans to those who will make the final plans.

In the following chapters, which take up in detail the problems of Flood Protection and Flood Prevention, these subjects are treated in the reverse order, for the amount of possible reduction by storage, and the portion of that storage which would be most economical and effective, must be determined before the modified form of Protection can be selected and estimates made of its cost. These chapters are, in a sense, the kernel of the Report of the Commission, and special effort has been made to show clearly and in detail the methods and results of the investigations along the lines of Flood Protection and Prevention. It is earnestly hoped that they will receive the most careful consideration and study.

CHAPTER VI.

STORAGE POSSIBILITIES ON THE ALLEGHENY AND MONONGAHELA BASINS.

Reservoir Sites — Features of Design — Estimates — Descriptions of Streams upon which Storage has been Considered — Important Features of Projects — Property Involved — Cost of Projects — Descriptions of Streams upon which Storage has not been Considered — Maintenance and Operation.

RESERVOIR SITES.

A large number of streams upon which storage seemed feasible was selected, either from a knowledge of the topography of their valleys, or by a study of the topographical sheets of the United States Geological Survey and of such other maps as were available. Practically all tributaries having a drainage area of fifty square miles or over were given consideration, as well as a number of smaller streams having particularly favorable location and topography. A careful examination of all promising streams was then made on the ground by the Engineer in Charge, and sites were selected and surveys made of those which warranted detailed study. This examination disclosed the fact that, in addition to the sites selected as being the most promising, there are other sites available on certain tributaries. In general, the surveys were extended far enough to ascertain the maximum storage possibilities up to economical limits, which were determined in each case by the point beyond which overflow would cause excessive damage. As there is obviously considerable territory where reservoir regulation is not feasible, the effort from the start was to secure storage sufficient to control the entire flood volume of the streams selected.

Flood Prevention is primarily the object of this part of the investigations and has in every case been given the first consideration; but on certain important streams, particularly on the Monongahela Basin, the conditions were so favorable for economic storage on a large scale, that reservoir capacity was found feasible to an amount which later studies proved to be considerably in excess of that necessary for flood control. If all the proposed projects were constructed to maximum capacity, a storage in excess of that required for flood control purposes would be obtained, amounting to 4,357,000,000 cubic feet on the Allegheny, and 17,937,500,000 cubic feet on the Monongahela, or a total of 22,294,500,000 cubic feet. This excess capacity, if constructed, could be used for navigation purposes and for power development, in addition to that part of the flood control capacity which, with proper manipulation of the reservoir system, could safely be used for these purposes.

The reservoir sites and capacities used at this time for the studies and estimates of the Commission are, of course, provisional and based on present conditions. Additional stream-flow data and final surveys and estimates preceding actual construction would doubtless, in some cases, bring about changes in the number, location and capacities of reservoir projects. Moreover, the other purposes for which the storage reservoirs would be used, would, in the final working-out of a reservoir system to serve jointly the needs of flood control, navigation, water supply and water power, necessitate changes in detail which it is not possible or essential to enter into at this time.

In certain cases, furthermore, changes in location may be brought about by fu-

ture economic developments in the valleys considered. The examinations and surveys of the Commission, recently completed, have, in fact, shown many otherwise suitable reservoir sites now unavailable because of railroad and other developments, which, a few years ago, would have been selected as favorable sites for reservoir projects. In the same way, if detailed location surveys for reservoir projects should later be made, certain projects here studied and suggested may then be found unfeasible because of excessive damages due to later developments in their valleys, and changes in these provisional locations would have to be made accordingly.

Of the forty-four reservoir projects upon which estimates of cost, capacity and effectiveness have been made, thirty-two were actually surveyed by the Flood Commission; the necessary estimate data for eleven others were obtained from the topographical sheets of the United States Geological Survey, supplemented by field investigations as to geological formation, forest cover, land and building values, etc.; and one (North Branch Red Bank Creek) was estimated by examination on the ground and comparison with other projects having similar characteristics. In the case of seven of the sites investigated, the projects are at or near locations previously selected by Mr. M. O. Leighton, in his studies made in 1907.

FEATURES OF DESIGN FOR ESTIMATE PURPOSES.

The surveys provided data sufficiently accurate for reliable preliminary estimates. In all cases special attention was given to the surface conformation of the valley at site of dam and such information secured relative to character of soil, depth to rock, etc., as could be determined by examination of the surface and of well borings, and by interviewing residents of the locality.

For convenience and expeditious treatment an average cross-section of dam was designed, similar to the spillway of the New Croton Dam and this was applied to each site, as conditions demanded. The dam section is shown on Plate 15. All the dams are entirely of masonry, with the exception of Sugar and Cussewago, which are low earthen dams, with masonry waste weirs. A typical cross-section of these earthen dams is also shown on Plate 15.

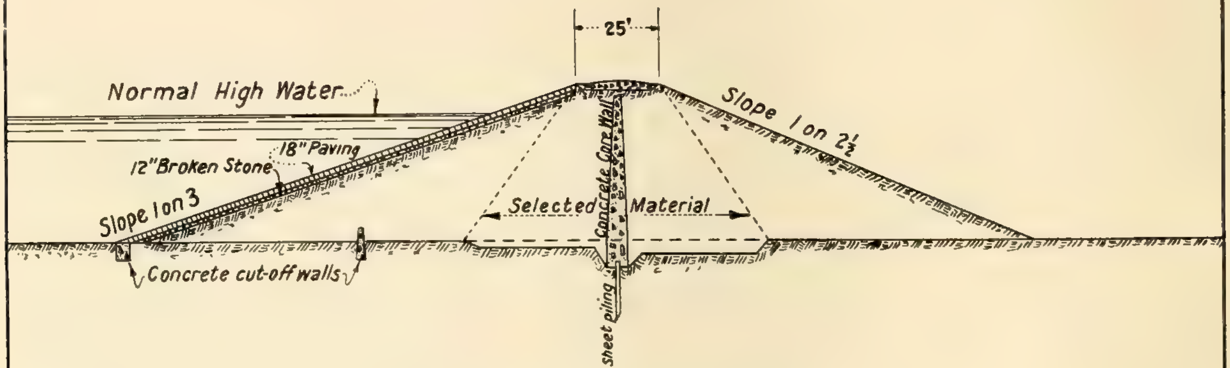
A sufficient number and area of gates has been estimated to permit emptying the reservoirs at the same rate as they would fill, with a rate of run-off equal to two inches of precipitation per 24 hours over the entire drainage area. This was considered advisable in order to properly control the arrival of tributary floods at Pittsburgh.

ESTIMATES.

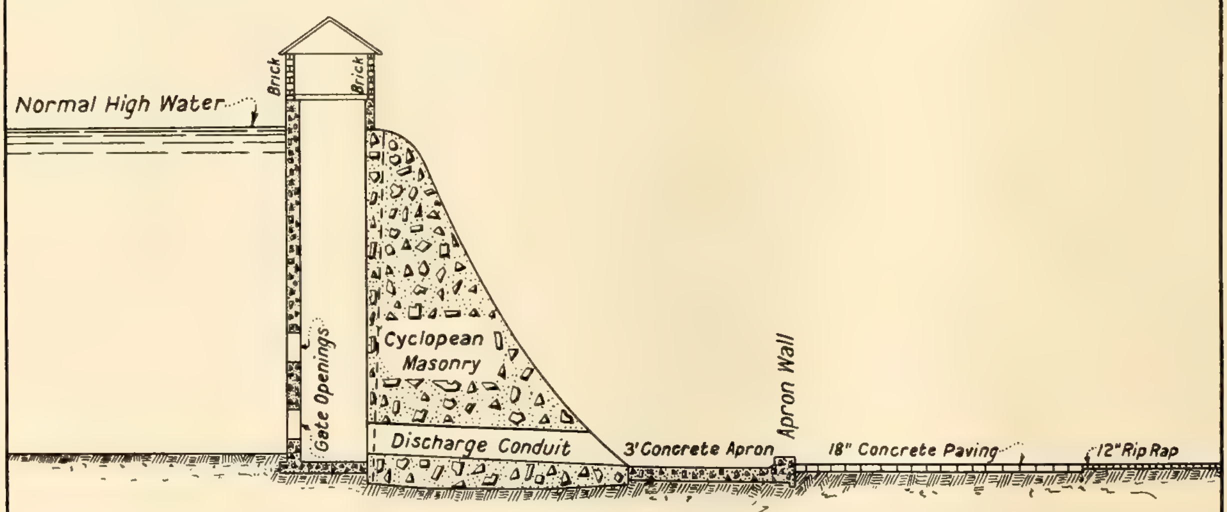
For the work of the main dam and appurtenances it was considered unnecessary to use a separate set of unit prices for each individual project. The best possible information as to suitable unit prices was obtained from well-known engineers and contractors, and, after careful consideration, together with an analysis of the various conditions obtaining as to local advantages for certain materials, transportation facilities, etc., a list of unit prices generally applicable to all projects was adopted.

The other items entering into the cost, such as land values, timber, coal, etc., were estimated for each individual project, upon information obtained on the ground and from those familiar with conditions. At many of the sites selected, as will be noted from the detailed descriptions of the respective projects, the valleys are narrow, with steep, rugged sides, unsuitable for cultivation; while what little bottom land obtains at scattered points is lowered in value by its isolation. Buildings were inspected and valued by the chiefs of parties at the time of survey. Costs of road, railroad and

FLOOD COMMISSION, PITTSBURGH, PENNA.



Typical Cross-Section
of
EARTHEN DAM



Typical Cross-Section
of
MASONRY DAM

bridge relocations were based upon the surveys, which were sufficiently complete to permit a reasonably accurate preliminary estimate. The value of the dwellings in numerous cases does not exceed $500, and many of them are of considerably less value. Other buildings, such as stores, schools and churches, are frequently of comparatively small value, which is also the case with those noted as mills, the greater number of which are saw or grist mills of small importance. There are, however, a number of exceptions, and in such cases costs of considerable amount have been allowed. Railroads involved range from narrow-gage lumber tramways to standard-gage single-track lines.

The important sub-divisions of cost of the respective reservoir projects are given in Table No. 33.

The following pages contain descriptions of streams upon which storage has been considered, and give the important features and estimates of cost of the reservoir projects. For convenient use in diagrams and tables, each project has been assigned a number. In addition, when there is more than one project on a stream, the reservoirs are numbered from the mouth upstreamward, as Clarion No. 1, Clarion No. 2, etc. The distances along streams are by the channel, and all elevations refer to mean sea level at Sandy Hook.

The areas under forest cover were determined from the forestry map prepared for the Flood Commission by the United States Forest Service. Some of the percentages appear high, as the term "wooded" includes all burned-over land and all land in scrub growth, and because numerous small patches of cleared land surrounded by woods could not be shown on a map of such a small scale.

The following features with regard to the reservoir projects are interesting to note:

Total cost of land		$1,429,300	
Total acres of land		50,678	
Average cost per acre		$28	
Highest flow line elevation	Youghiogheny No. 5	2,370	feet
Lowest flow line elevation	Crooked	855	"
Highest dam	Mahoning No. 2	143	"
Lowest dam	Casselman No. 1	29	"
	*Cussewago	19	"
Longest crest	Allegheny No. 2	1,670	"
Shortest crest	Youghiogheny No. 5	410	"
	*Cussewago	2,840	"
Longest reservoir	West Fork	28.9	miles
Shortest reservoir	Casselman No. 1	1.1	"
Greatest surface area	West Fork	3,455	acres
Smallest surface area	Casselman No. 1	77	"
Greatest average depth	Cheat No. 1	60.5	feet
Least average depth	Cussewago	8.0	"
Greatest capacity	Cheat No. 2	7,294,100,000	cu. ft
Smallest capacity	Casselman No. 1	66,300,000	" "
Greatest cost per mill. cu. ft. capacity	East Sandy No. 2	$2,611	
Lowest cost per mill. cu. ft. capacity	Buckhannon	$ 112	

*Note: Cussewago is an earthen dam.

For convenient reference the main features of the projects are grouped in Tables Nos. 31 and 32.

ALLEGHENY BASIN.

ALLEGHENY RIVER.

The Allegheny River having been generally described in Chapter II, reference to it at this point will be confined mostly to reservoir possibilities.

The topographical formation along the river, at a number of places, is exceedingly favorable for dams of great height and reservoirs of very large capacity. Furthermore, while the valley here and there widens advantageously for volume, the area of land overflowed would be comparatively small, as the hills rise steeply, for the most part, from narrow, poorly cultivated bottom land. The land is not of high value, and settlements are small and widely separated; so that, considering these features, there would be no great difficulty in building several reservoirs on the main stream in the upper half of that portion which lies between Pittsburgh and the mouth of French Creek. The chief difficulty, however, is with the railroad development along the entire length of the main stream, which would make large structures costly and, along most of the river, impossible. A few miles below the mouth of French Creek, two or more dams of moderate height might be built without interfering with convenient operation of the Buffalo & Allegheny Valley Railroad, a division of the Pennsylvania, which is located on the left bank close to the stream, at an average elevation above water of nearly 30 feet. The railroad, however, would have to be raised slightly to allow any considerable pondage.

Above Oil City, which is 8 miles upstream from French Creek, the valley was examined and three sites offering opportunities for treatment were selected. A single-track branch of the Buffalo & Allegheny Valley Railroad follows along the right bank about 20 feet above water, and this would have to be relocated at a higher elevation for much of the stretch from a point a short distance above Oil City to near Irvineton, which is at the mouth of Brokenstraw Creek, 50 miles above Oil City and 8 miles below the city of Warren. Rafting or floating of boat bottoms and barges, from points in the locality, constitutes the river business, which is rapidly decreasing and, according to those engaged in the lumber business, is now of comparatively small value.

The river in this region has an average width of about 700 feet, with banks ranging from 10 to 20 feet above water. The bed of the valley is in or under the Pocono sandstone nearly to Tidioute, and continuing upstream, the formation is the Catskill shale and sandstone. The valley, to a short distance below Irvineton, is for the most part narrow, but here and there broadens out, with cultivated flats, while back of these and along the narrow places, the hills, covered with second-growth timber and brush, have a steep rise to about 600 feet above river.

Reservoir No. 1. (18.)*

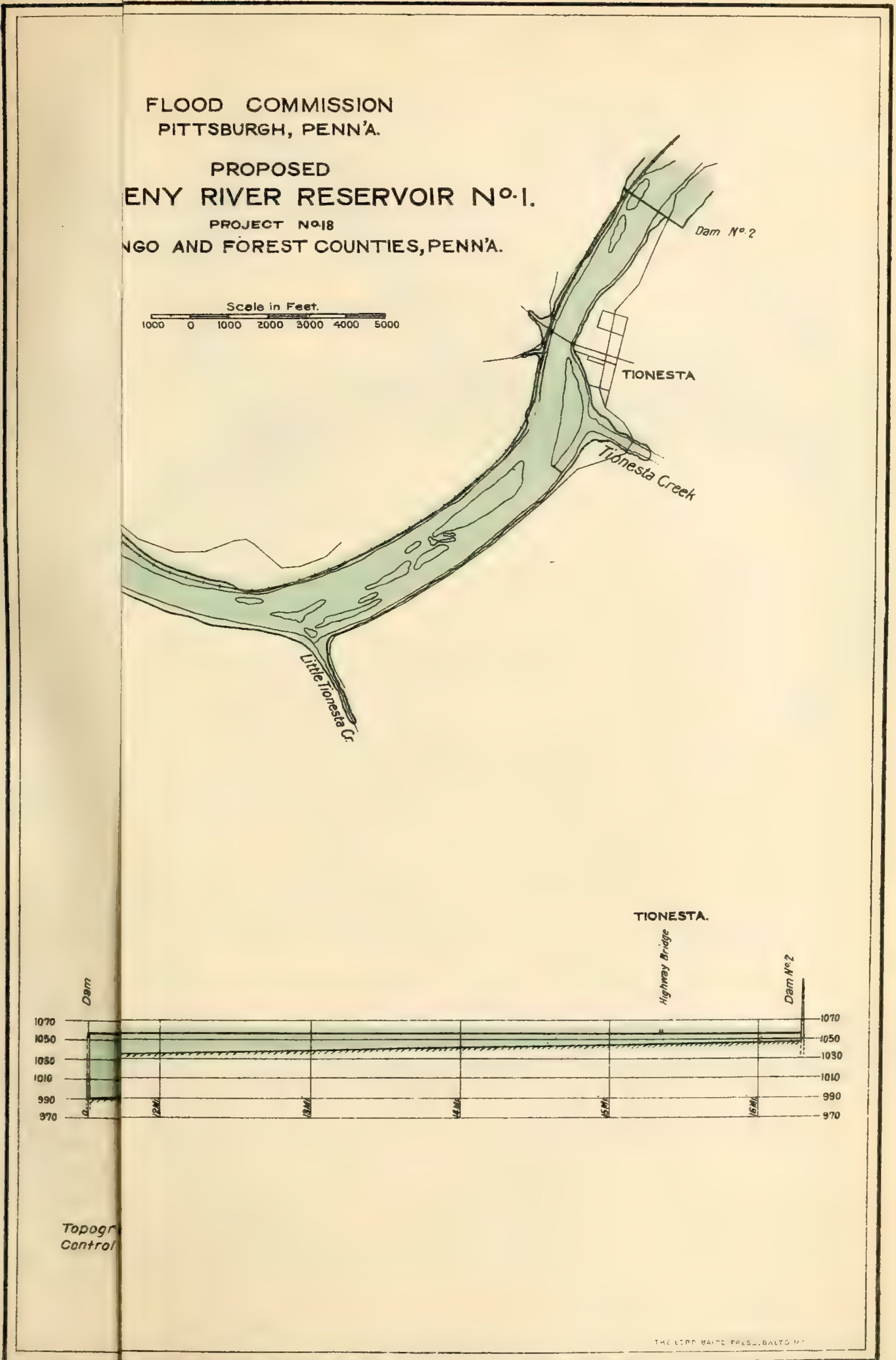
This project, as proposed, would have its location 138.6 miles above the mouth of the Allegheny, at Pittsburgh, 4.4 miles above Oil City and 175.4 miles below the source of the river, in Potter County, Pennsylvania. Geological inspection of the dam site indicates that rock footings can be reached practically at ground surface. A very high rock cliff on the left bank stands out prominently above the proposed site.

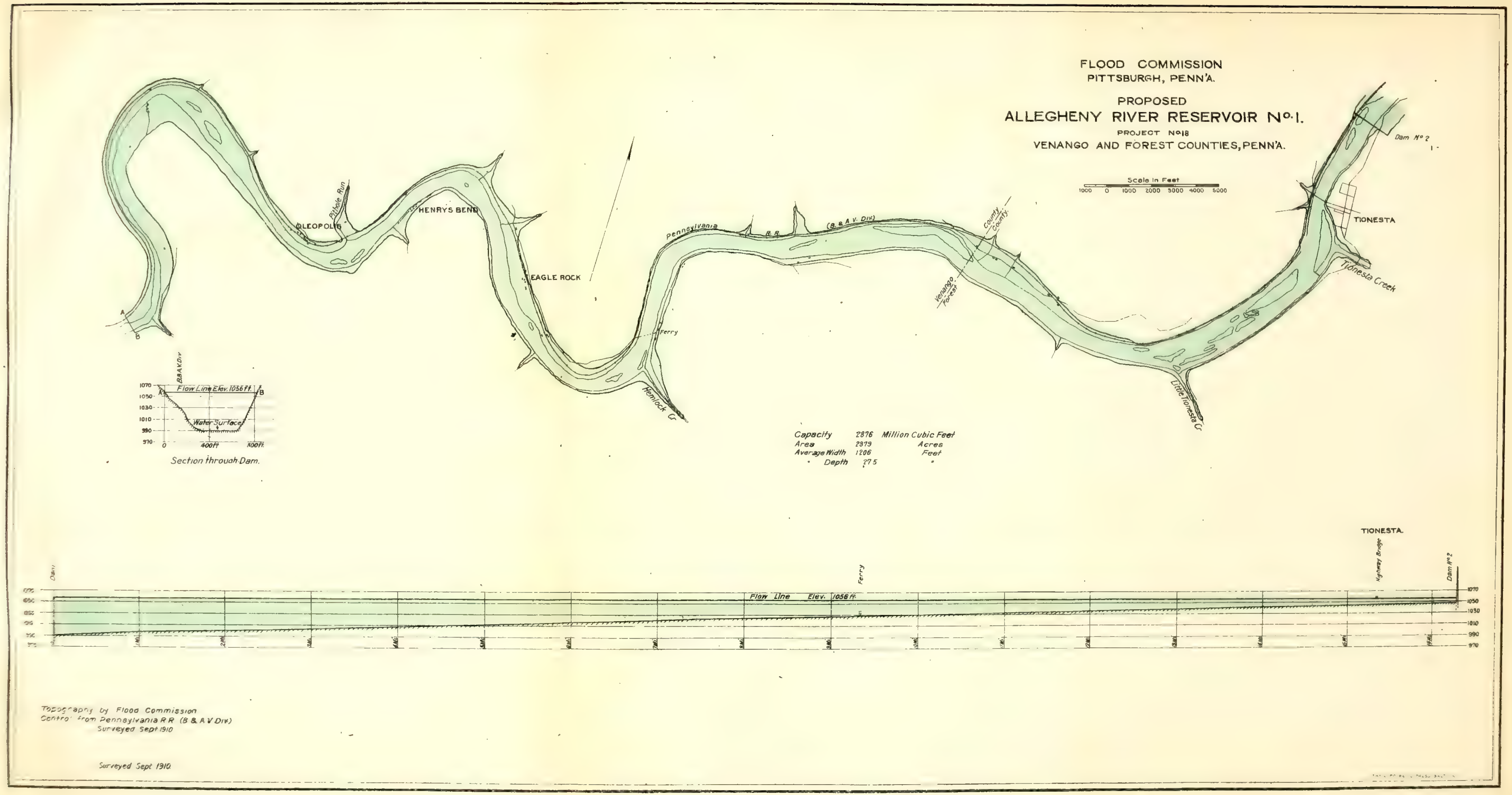
There are no large settlements involved, but at the dam the single-track railroad would have to be elevated about 30 feet to the hill slope, and continued upstream, with a very slight grade, to above the flow line of Dam No. 2. The flow line is kept down low enough to avoid interference, by fluctuations of level, with the town of Tionesta, having a population of about 800, which is on the left bank, near the head of the project and immediately above the mouth of Tionesta Creek. This project backs against Dam No. 2, with a depth of about 9 feet over low water of open stream.

*Refers to numbers assigned to respective projects.

Allegheny River, Pa., February, 1911.
View up stream, showing crest of proposed Dam No. 1.

Allegheny River, Pa., February, 1911.
View down stream, from a point near site of proposed Dam No. 1.


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
ENY RIVER RESERVOIR No. I.
PROJECT No. 18
NGO AND FOREST COUNTIES, PENN'A.
Scale in Feet.
1000 0 1000 2000 3000 4000 5000
Dam No. 2
TIONESTA
Tionesta Creek
Little Tionesta Cr.
TIONESTA.
Dam
Highway Bridge
Dam No. 2
1070
1050
1030
1010
990
970
Topogr
Control


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
ALLEGHENY RIVER RESERVOIR No. 1.
PROJECT No 18
VENANGO AND FOREST COUNTIES, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
OLEOPOLIS
Pithole Run
HENRYS BEND
EAGLE ROCK
Pennsylvania R.R. (B. & A.V. Div.)
Ferry
Hemlock Cr.
Venango County
Forest County
Little Tionesta Cr.
Tionesta Creek
TIONESTA
Dam No 2
Flow Line Elev. 1056 ft.
Water Surface
Section through Dam.
Capacity 2876 Million Cubic Feet
Area 2379 Acres
Average Width 1206 Feet
" Depth 27.5 "
Flow Line Elev. 1056 ft.
Highway Bridge
Topography by Flood Commission
Control from Pennsylvania R.R. (B & A.V. Div.)
Surveyed Sept 1910
Surveyed Sept 1910

Important Features.

Drainage area above dam	4,272 sq. mi.
Capacity of reservoir	2,876,300,000 cu. ft.
Height dam above stream	63 feet
Length of crest	810 "
Elevation of crest	1,056 "
Length of reservoir	16.3 miles
Average width	1,206 feet
Average depth	27.5 "
Area of surface	2,379 acres

Property Involved.

Land below flow line, 1,066 acres; marginal strip, 185 acres; total, 1,251 acres (55% wooded).

Oleopolis: dwellings, 8; barns, 2. Henry's Bend: dwellings, 18; barns, 3. Eagle Rock: dwellings, 5; barns, 1; stores, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 24; barns, 3; stores, 1; hotels, 1; cemeteries, 1; ordinary highway, 13 miles; railroad, 16 miles of main line.

Estimate of Cost.

Dam		
Excavation	$ 19,900	
Concrete	325,300	
Riprap paving	12,000	
Gate house and appurtenances	45,500	
		$ 402,700
Land		52,100
Buildings		46,000
Railroads		560,000
Total		$1,060,800
Total, plus 15% for engineering and contingencies		1,219,900
Cost per million cubic feet of storage		425

Reservoir No. 2, (19).

The dam would have its location about one mile above Tionesta and 154.9 miles from Pittsburgh. Practically all of four small villages would come under flow line, namely: West Hickory, on right bank, population 250; East Hickory, on left bank, population 180; Middletown, 1 mile up Hickory Creek, population 80; Endeavor, 1.5 miles up Hickory Creek, population 100.

Tidioute, population 1300, on the right bank and near the upper end of project, would not be interfered with, as the flow line along that part of the river would be well within the banks, with the exception of a small area at the mouth of a tributary. Fortunately the topography is suitable, just back of the villages, to receive the present developments and allow for enlargements. A lumber railroad, the Hickory Valley Railroad, would have to be moved higher up on the hill for a distance of nearly two miles, between the West Hickory bridge and the vicinity of Endeavor. The most serious damage is to two of the sawmills at the latter place, the combined capacity of which is about 140,000 feet B. M. per day. A tannery of moderate size, located at West Hickory, would have to be rebuilt on the higher ground. An oil field crosses this project and about 40 old wells, producing an average of probably not more than one barrel each per day, would come under flow line. The head of the project touches No. 3 with a depth of water at the lower face of that dam of about 9 feet over present normal stream surface.

Important Features.

Drainage area above dam	3,652 sq. mi.
Capacity of reservoir	4,877,900,000 cu. ft.
Height dam above stream	66 feet
Length of crest	1,670 "
Elevation of crest	1,113 "
Length of reservoir	15.9 miles
Average width	1,701 feet
Average depth	34.5 "
Area of surface	3,257 acres

Property Involved.

Land below flow line, 1,737 acres; marginal strip, 194 acres; total, 1,931 acres (27% wooded).

West Hickory: dwellings, 38; schools, 1; churches, 1; stores, 7; hotels, 2; tanneries, 1; combination railroad and highway bridge. East Hickory: dwellings, 34; stores, 3; grist mills, 1. Middletown: dwellings, 19; barns, 1; schools, 1; stores, 1. Endeavor: dwellings, 21; barns, 2; schools, 1; churches, 1; saw mills, 2. In other parts of the valley are the following, which have been included in the estimate: dwellings, 33; barns, 7; schools, 2; express office, 1; Forest County Home; oil wells, 40; ordinary highway, 12.3 miles; macadam highway, 2.9 miles; railroad, 11.3 miles of main line.

Estimate of Cost.

Dam		
Excavation	$ 32,300	
Concrete	704,700	
Riprap paving	21,400	
Gate house and appurtenances	48,500	
		$ 806,900
Land		118,300
Buildings		952,800
Railroads		600,000
Bridges		180,300
Total		$2,658,300
Total, plus 15% for engineering and contingencies		3,057,000
Cost per million cubic feet of storage		626

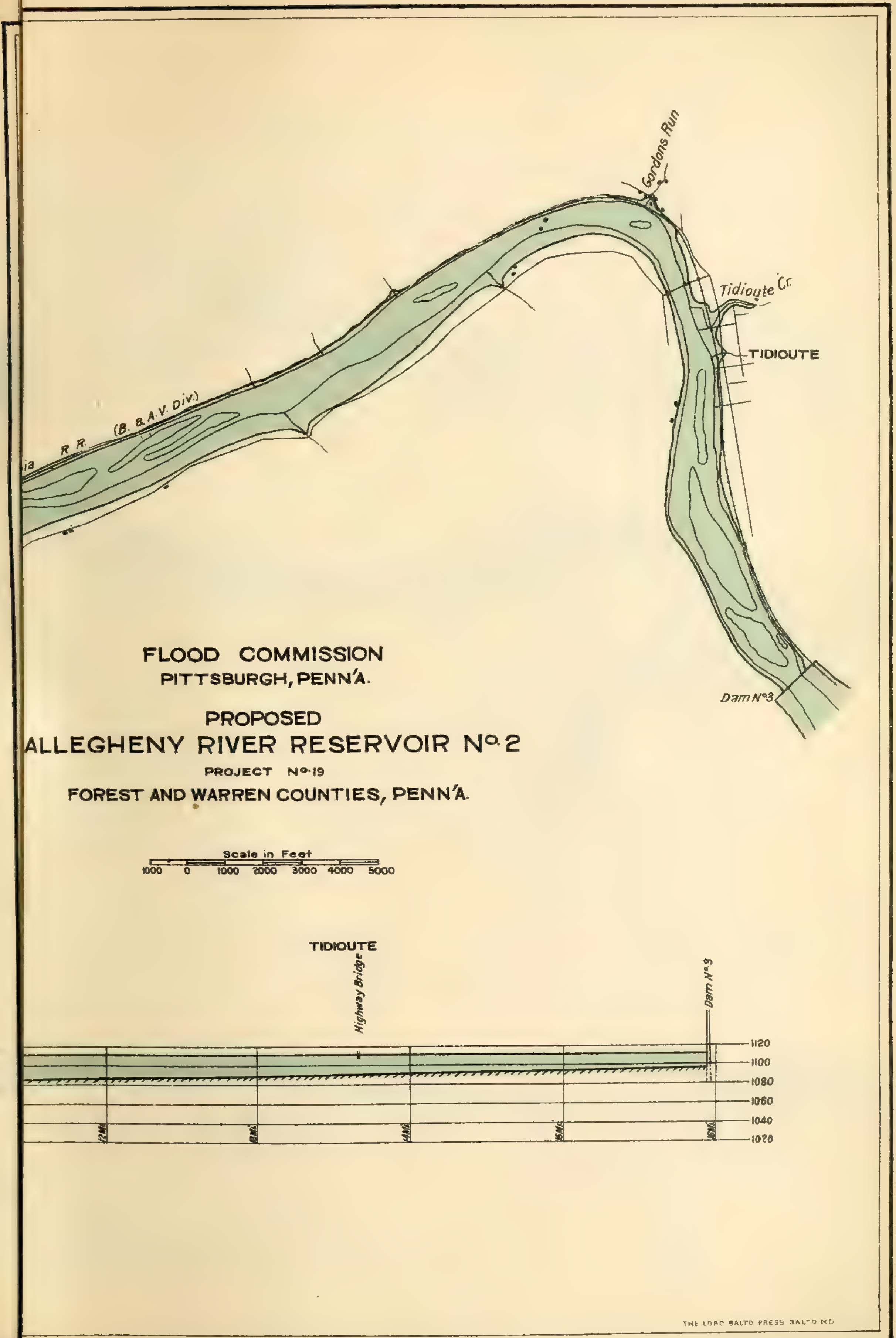
Reservoir No. 3. (20.)

This project, as proposed, would have its dam two miles above Tidioute and 170.8 miles above Pittsburgh. Estimates are made for rock foundation at dam. The flow line at the head of the reservoir would reach about two miles above the mouth of Brokenstraw Creek, and a considerable area of bottom land below the creek mouth would be flooded. The railroad along the upper fourth of the project would not have to be disturbed and the buildings which are scattered along the stream are mostly small dwellings located on limited areas of farmed bottom land.

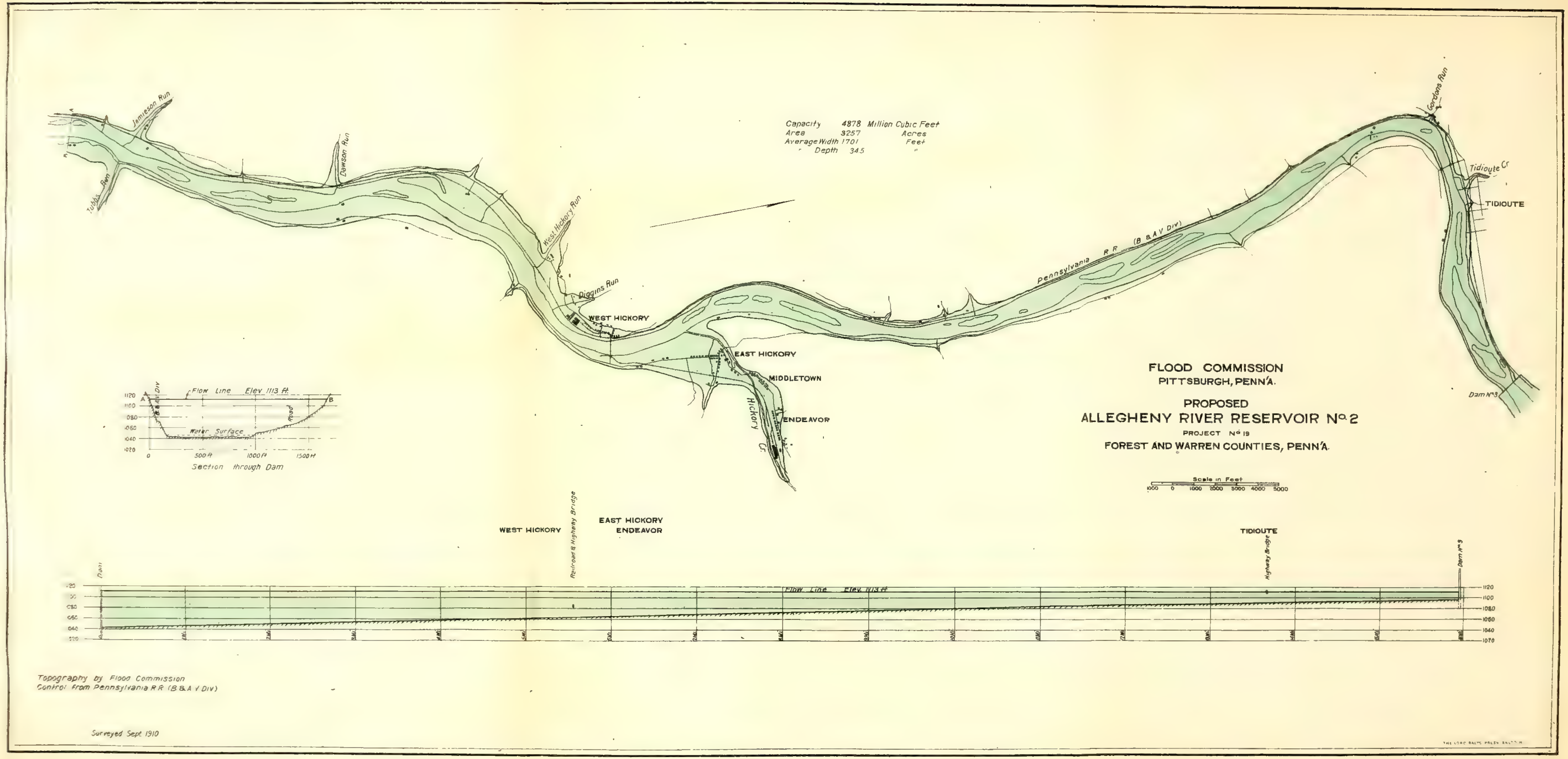
Important Features.

Drainage area above dam	3,488 sq. mi.
Capacity of reservoir	2,663,600,000 cu. ft.
Height dam above stream	54 feet
Length of crest	1,415 "
Elevation of crest	1,158 "
Length of reservoir	14.7 miles
Average width	1,384 feet
Average depth	25.0 "
Area of surface	2,461 acres

Allegheny River, Pa., February, 1911.
View down stream, showing crest of proposed Dam No. 3.



THE LORD BALTO PRESS BALTO MD


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
ALLEGHENY RIVER RESERVOIR No. 2
PROJECT No. 19
FOREST AND WARREN COUNTIES, PENN'A.
Capacity 4878 Million Cubic Feet
Area 3257 Acres
Average Width 1701 Feet
" Depth 34.5 "
Jamieson Run
Tubbs Run
Dawson Run
West Hickory Run
Diggins Run
WEST HICKORY
EAST HICKORY
MIDDLETOWN
ENDEAVOR
Hickory Cr.
Pennsylvania R.R. (B.B.A.V. Div)
Gordons Run
Tidioute Cr.
TIDIOUTE
Dam No. 3
Flow Line Elev. 1113 ft.
Water Surface
Road
Section through Dam
Scale in Feet
WEST HICKORY
Railroad & Highway Bridge
EAST HICKORY
ENDEAVOR
TIDIOUTE
Highway Bridge
Dam
Dam No. 3
Topography by Flood Commission
Control from Pennsylvania R.R. (B.B.A.V. Div)
Surveyed Sept. 1910

Property Involved.

Land below flow line, 1,331 acres; marginal strip, 180 acres; total, 1,511 acres (36% wooded).

Thompson; dwellings, 9; barns, 3; schools, 1; stores, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 20; barns, 12; schools, 1; ordinary highway, 16.6 miles; railroad, 10.6 miles of main line.

Estimate of Cost.

Dam		
Excavation	$ 26,000	
Concrete	485,600	
Riprap paving	18,000	
Gate house and appurtenances	48,400	
		$ 578,000
Land		76,100
Buildings		61,100
Railroads		490,000
Total		$1,205,200
Total, plus 15% for engineering and contingencies		1,386,000
Cost per million cubic feet of storage		520
Total capacity of three projects		10,417,800,000 cu. ft.
Total cost of three projects		$5,662,900

BUFFALO CREEK.

Buffalo Creek is the largest tributary entering the Allegheny River on the right bank for a distance of over 100 miles above Pittsburgh. It rises in the eastern edge of Butler County and joins the Allegheny 28.6 miles above Pittsburgh, at the town of Freeport. The elevation of the source is 1380 feet above the sea and the river is joined, after the stream flows a distance of 32 miles, at an elevation of 736 feet, which makes a fall of 20.1 feet per mile. In the lower reaches, the stream flows through a narrow valley, with steep hillsides.

The drainage basin has an area of 167 square miles, with the high parts of the watershed ranging from 1000 feet, near the mouth, to 1300 feet and 1500 feet in the upper portions. About 34 per cent of the basin is under forest cover. The greater part of the valley considered feasible for reservoiring lies in the lower productive coal measures, but no coal is extensively mined and it is probable that the quality is not of sufficiently high grade to cause serious interference with a reservoir project. The site was not surveyed but its feasibility determined from the U. S. Geological Survey map and from an examination made in the field.

Reservoir Project. (1).

The topography of the valley a very short distance above the mouth is favorable for a reservoir, but due to the presence of the Winfield Railroad, which is located along the right bank, a project was not considered on the lower reaches. A site, with rock footings, was selected immediately above the mouth of Rough Run, and 11.7 miles from the Allegheny.

Important Features.

Drainage area above dam	98 sq. mi.
Capacity of reservoir	882,800,000 cu. ft.
Height dam above stream	100 feet
Elevation of crest	980 "

Important Features.—(Continued.)

Length of reservoir	6.3 miles
Average width	848 feet
Average depth	31.0 "
Area of surface	647 acres

Property Involved.

Land below flow line, 616 acres; marginal strip, 104 acres; total, 720 acres (30% wooded). Ordinary highway, 2.0 miles; highway bridges, 4.

Estimate of Cost.

Dam and appurtenances	$350,000	
Land and damages	70,000	
		420,000
Total, plus 15% for engineering and contingencies		483,000
Cost per million cubic feet of storage		546

LOYALHANNA CREEK.

Loyalhanna Creek flows a distance of 46 miles, in a northwesterly direction, from its headwaters on the Laurel ridge in the southeastern part of Westmoreland County, and joins the Kiskiminetas on the left bank at the town of Saltsburg, 26 miles from the Allegheny River. From an elevation of 1120 feet, 33 miles from the mouth, the stream falls at the rate of 8.8 feet per mile, in a generally direct route, but with numerous small bends, joining the Kiskiminetas at an elevation of 828 feet.

The drainage basin, lying in the eastern part of Westmoreland County, has an area of 278 square miles, a full length of 29 miles and an average width of 10 miles. The higher elevations, on the east and west, below Latrobe, range around 1200 feet, while some miles southeast of that town, the Chestnut ridge, through which the stream passes in a deep ravine, reaches elevations of over 2000 feet. The Laurel ridge, paralleling the Chestnut ridge, 10 miles further to the southeast, has not been covered by surveys, and reliable data regarding levels are not available. About 31 per cent of this basin is wooded.

The Loyalhanna receives large amounts of mine drainage, and its waters are therefore highly acid, especially in dry seasons, when the discharge at the mouth drops as low as 10 second-feet, or 0.036 second-foot per square mile. The discharge is estimated to reach a maximum of 14,180 second-feet or 51 second-feet per square mile. There is a fluctuation of about 12 feet between high and low water.

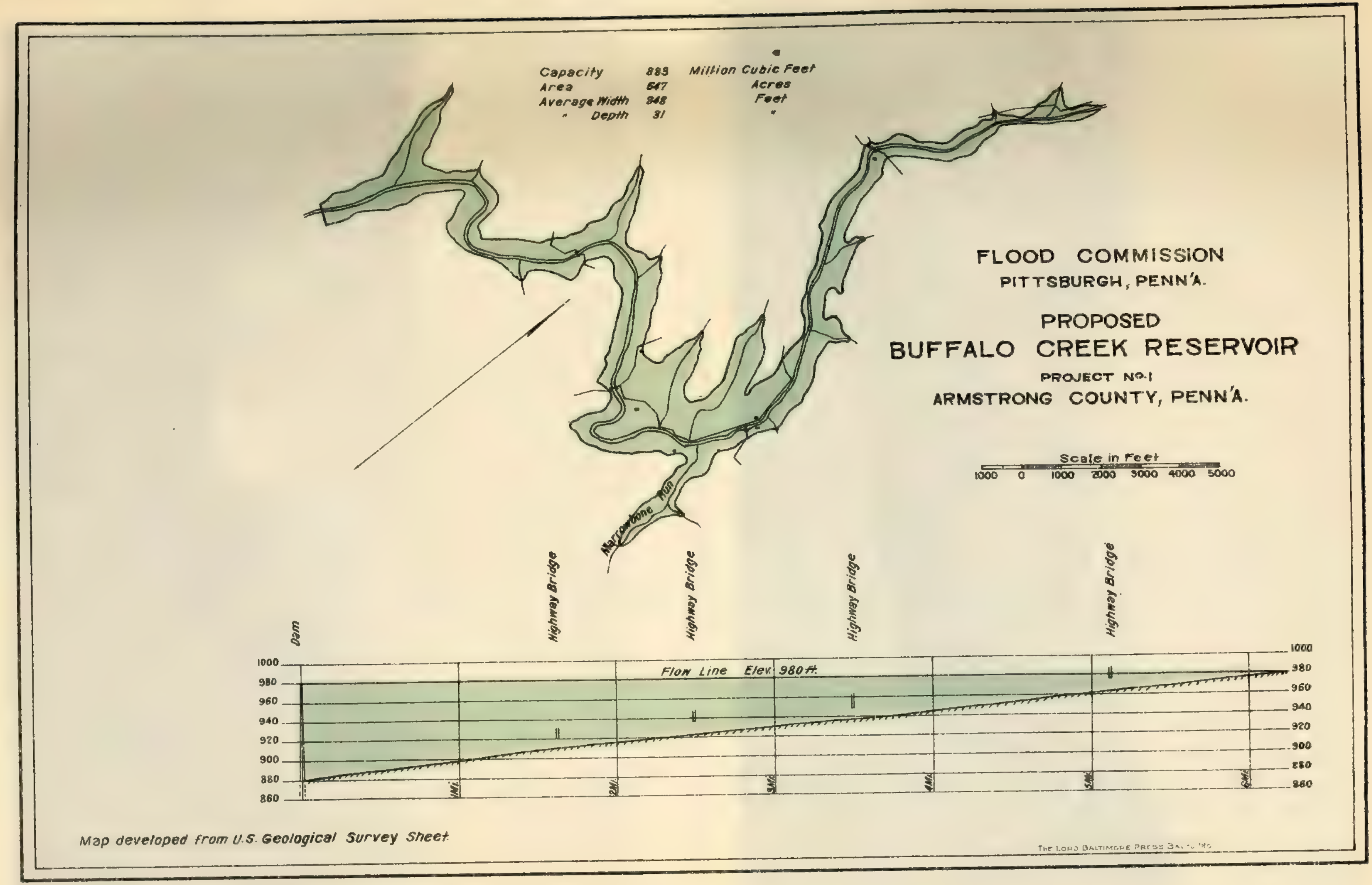
The principal towns and their respective populations are: Ligonier, 1,570; Latrobe, 8,780; New Alexandria, 500.

Reservoir Project. (2).

The topography of the stream is favorable for large storage. The site selected for the dam is 1.3 miles from the mouth and an inspection of the bed of the stream and the side hills indicates that rock footings can probably be reached at slight depth. While the hillsides are steep and close to the stream in many places, here and there they are set apart sufficiently to enable large pondage. On the flats, in these comparatively wide places, there is considerable farm land of good quality. The slopes on the uncultivated portions are covered with second-growth timber and brush.

The greater part of the lower reaches lies within the lower coal measures, with the Upper Freeport coal, so far as can be ascertained, coming up above stream surface

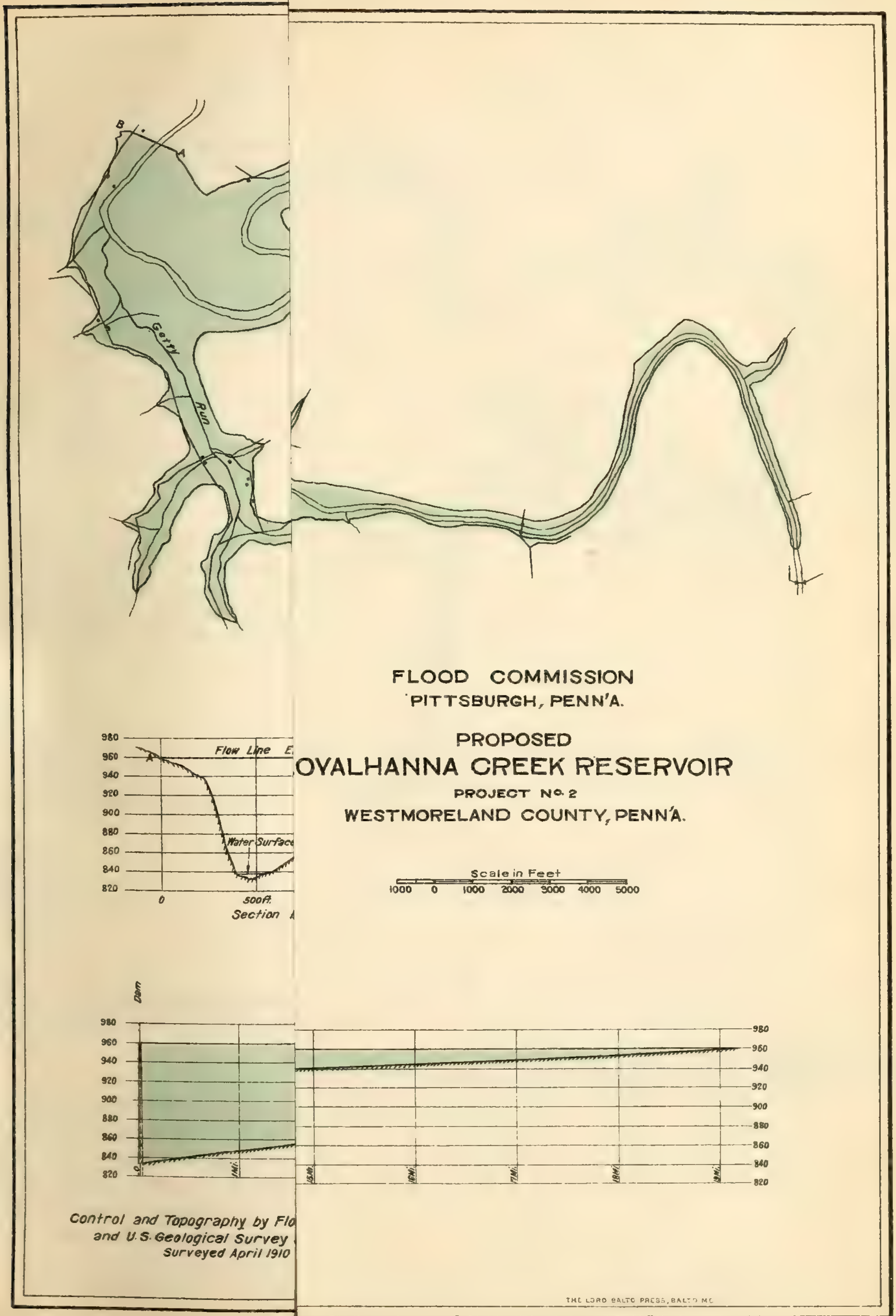
PLATE 19

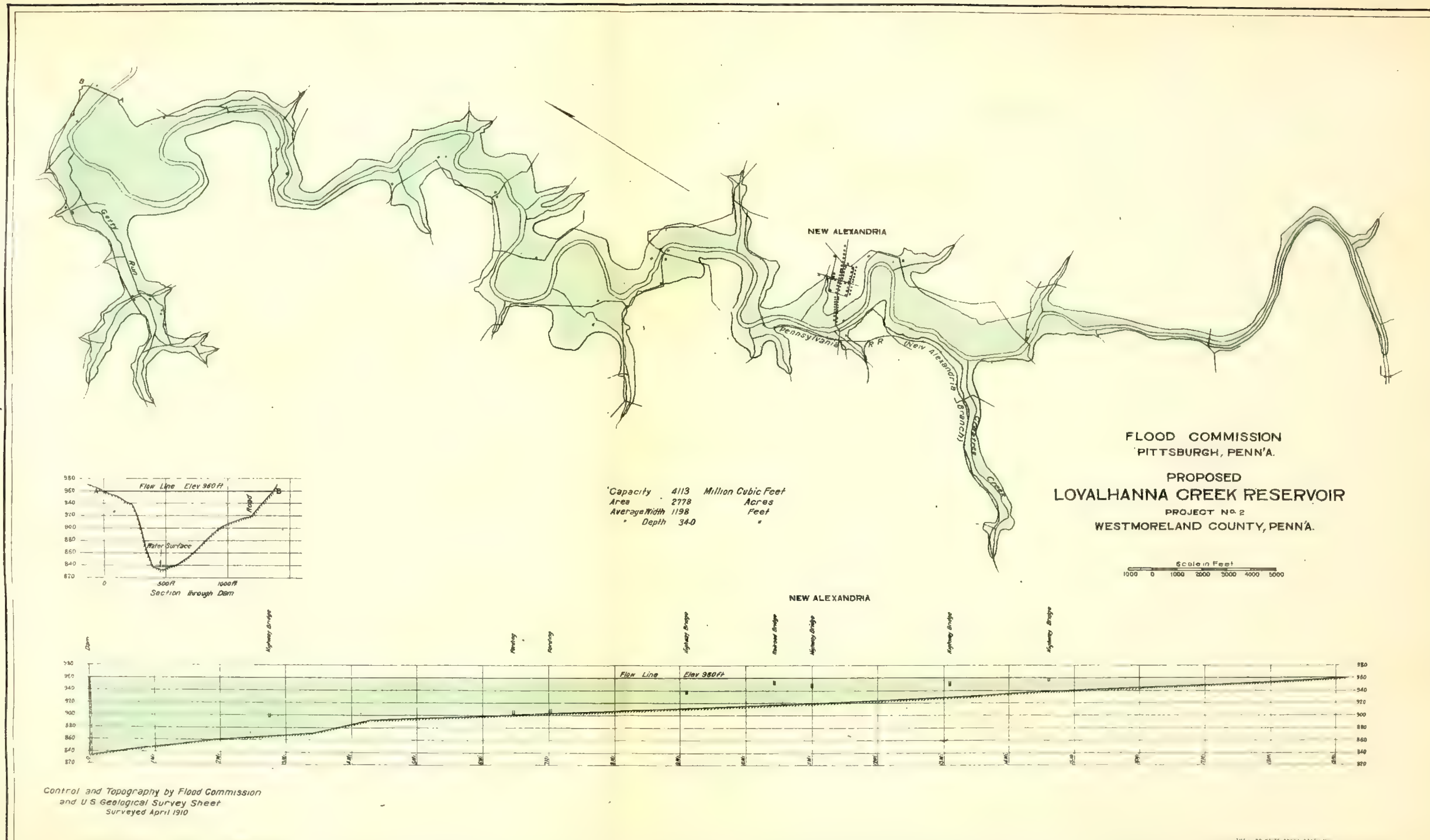


The Lord Baltimore Press Balto. Md.

LOYALHANNA CREEK, PA., OCTOBER, 1910.
View up stream, showing crest of proposed dam.

LOYALHANNA CREEK, PA., OCTOBER, 1910.
View up stream, from a point about 5 miles south of Saltsburg.


Gerry Run
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
OYALHANNA CREEK RESERVOIR
PROJECT No. 2
WESTMORELAND COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line E
Water Surface
500ft.
Section A
Dam
Control and Topography by Flo
and U.S. Geological Survey
Surveyed April 1910
THE LORD BALTO PRESS, BALTO MD


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
LOVALHANNA CREEK RESERVOIR
PROJECT No. 2
WESTMORELAND COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
NEW ALEXANDRIA
Gerry Run
Pennsylvania R R
New Alexandria Branch
Capacity 4113 Million Cubic Feet
Area 2778 Acres
Average Width 1198 Feet
" Depth 34.0 "
Flow Line Elev 960 ft
Water Surface
Road
500 ft
1000 ft
Section through Dam
NEW ALEXANDRIA
Flow Line Elev 960 ft
Control and Topography by Flood Commission
and U S Geological Survey Sheet
Surveyed April 1910

at a point about three miles above the proposed dam and keeping below the proposed flow line for a distance of three miles upstreamward. The Lower Freeport, a short distance under the above bed, would probably be involved for a distance of two miles along the immediate valley.

The only real settlement on the stream, between Saltsburg and Latrobe, 22 miles apart, is the village of New Alexandria, at which place coal is now being mined in large quantities. Latrobe is on the main line of the Pennsylvania Railroad, at the foot of Chestnut ridge.

Important Features.

Drainage area above dam	277 sq. mi.
Capacity of reservoir	4,112,500,000 cu. ft.
Height dam above stream	122 feet
Length of crest	1,370 "
Elevation of crest	960 "
Length of reservoir	19.1 miles
Average width	1,198 feet
Average depth	34.0 "
Area of surface	2,778 acres

Property Involved.

Land below flow line, 2,621 acres; marginal strip, 268 acres; total, 2,889 acres (36 % wooded).

New Alexandria: dwellings, 9; highway bridges, 1.

In other parts of the valley are the following, which have been included in the estimate: dwellings, 15; barns, 15; grist mills, 1; ordinary highway, 7.8 miles; railroad, 1.9 miles of branch line; railroad bridges, 1; highway bridges, 3.

Estimate of Cost.

Dam		
Excavation	$ 25,400	
Concrete	711,900	
Riprap paving	14,900	
Gate house and appurtenances	31,500	
		$ 783,700
Land		114,200
Buildings		27,900
Highways		18,600
Railroads		50,000
Bridges		68,200
Total		$1,062,600
Total, plus 15% for engineering and contingencies		1,222,000
Cost per million cubic feet of storage		297

BLACK LICK CREEK.

Black Lick Creek has its source in the western part of Cambria County, flows 34 miles in a westerly direction to the village of Black Lick, where it is joined by a branch called Two Lick, coming from the northern portion of Indiana County, and from this junction continues a distance of 11 miles, entering the Conemaugh River a short distance below Blairsville, 41 miles from the Allegheny River. The source of the stream has an elevation of 2160 feet, and from there to the mouth, where the elevation is 894 feet, the average fall per mile is 28.1 feet.

The drainage basin is notably fan-shaped, and its area of 414 square miles lies mainly within Indiana County. About 39 per cent of the basin is wooded. The upper

portions of the watershed attain elevations ranging from 1500 to 2400 feet above tide, while the north and south divides, in the vicinity of the Conemaugh, have elevations of about 1200 feet. From the northeast slope flows the West Branch of the Susquehanna.

The discharge at Black Lick, 6 miles above the mouth, from a drainage area of 386 square miles, during the term of the record since August, 1904, has reached a maximum of 19,620 second-feet, or 50.8 second-feet per square mile, and a minimum of 6 second-feet, or 0.016 second-foot per square mile. There is a difference of about 15 feet between high water and low water.

Coal-bearing strata are found in most parts of the valley, but nothing of commercial value is located immediately along the stream below the village of Black Lick, at which place the Pittsburgh coal bed is mined well up on the hill. The Freeport coal, coming next below, geologically, is believed to be well under the bed of the stream.

As the site is inadequate for complete control of floods on Black Lick and as the creek so frequently contributes to flood troubles at Pittsburgh, it would be very desirable to obtain additional storage, which might be found feasible, upon further investigation, along the main stream and on Two Lick Creek above Black Lick station. Two railroads, however, are on the former stream and one on the latter, at rather low grade, and there is some question about finding economic locations.

Reservoir Project. (3).

The location for the dam, as selected, would be 0.3 of a mile from the mouth, with rock footings at slight depth. Two small communities would be involved and a small portion of the town of Black Lick, at which place it would be necessary to elevate a short stretch of the Indiana Branch of the Pennsylvania Railroad to the extent of several feet. Some of the land in the reservoir section of the valley, immediately along the stream, is fairly well farmed, but much of it is in an uncultivated state and covered with brush or second-growth timber. The town of Black Lick and other developments in that vicinity prevent economic enlargement.

Important Features.

Drainage area above dam	414	sq. mi.
Capacity of reservoir	1,454,700,000	cu. ft.
Height dam above stream	63	feet
Length of crest	1,330	"
Elevation of crest	960	"
Length of reservoir	10.6	miles
Average width	1,037	feet
Average depth	25.0	"
Area of surface	1,333	acres

Property Involved.

Land below flow line, 1,098 acres; marginal strip, 161 acres; total, 1,259 acres (45% wooded).

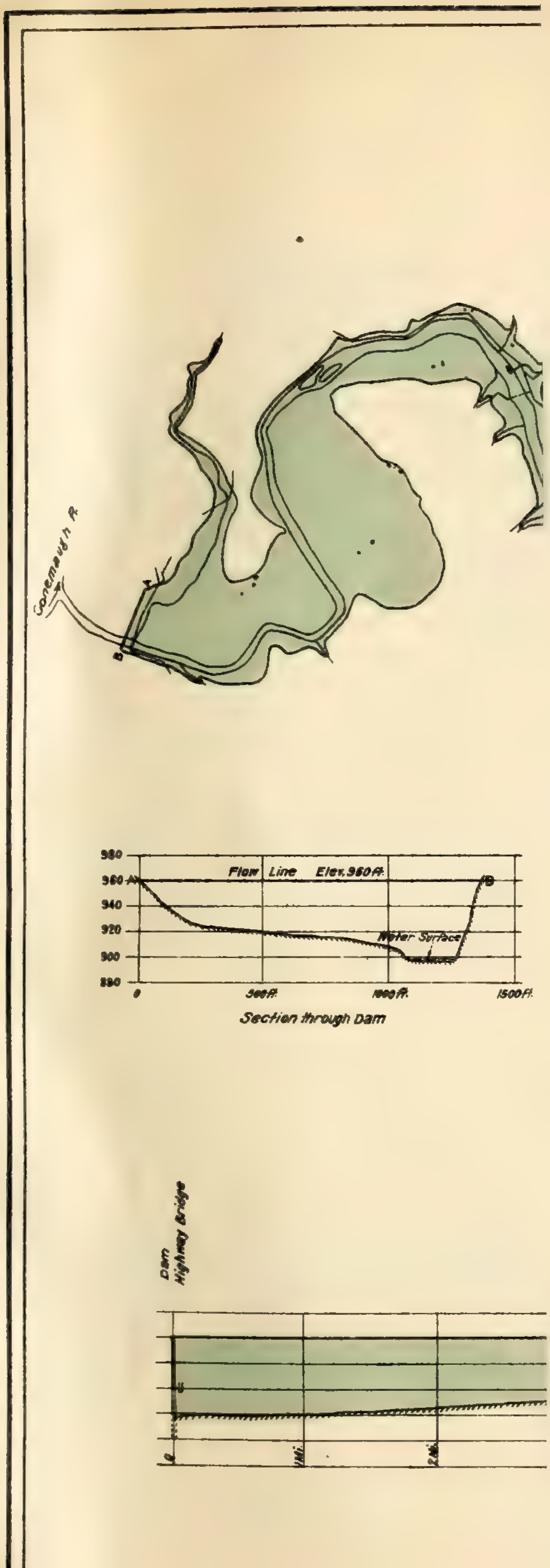
Campbells Mills: dwellings, 5; barns, 2; grist mills, 1; blacksmith shops, 1; highway bridges, 1. Grafton: dwellings, 13; 0.3 mile of street, 50 feet wide, between Grafton and Black Lick; highway bridges, 1. Black Lick: dwellings, 20; barns, 5. In other parts of the valley are the following, which have been included in the estimate: dwellings, 17; barns, 10; railroads, 1.0 mile of main line and 0.2 mile of branch line; highway bridges, 2.

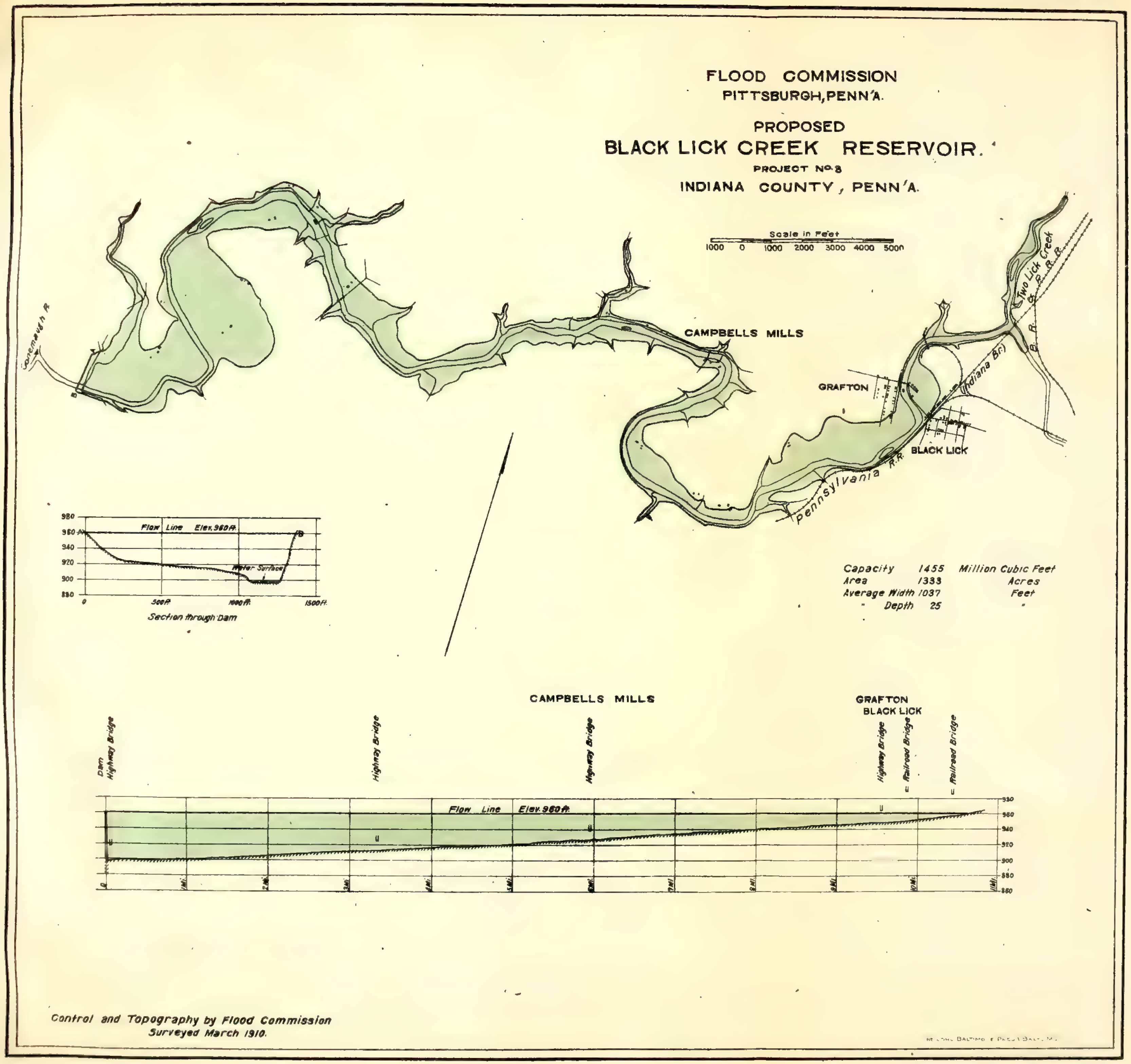
Estimate of Cost.

Dam		
Excavation	$ 17,400	
Concrete	358,100	
Riprap paving	5,400	
Gate house and appurtenances	41,800	
		$ 422,700

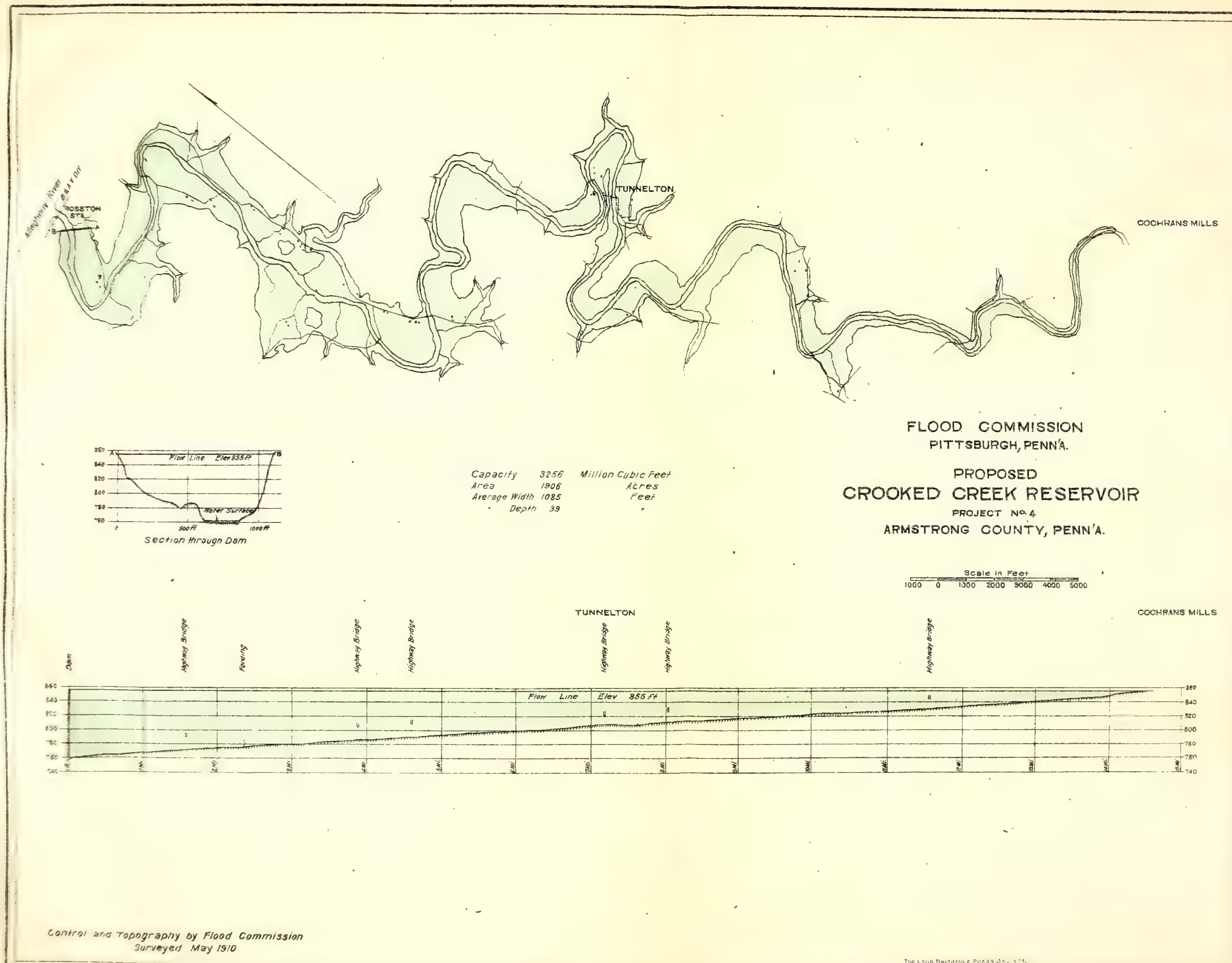
Crooked Creek, Pa., February, 1911.
View up stream, showing crest of proposed dam.

Black Lick Creek, Pa., October, 1910.
View up stream, from a point 2 miles above mouth.


Conemaugh R.
980
960
940
920
900
890
Flow Line Elev. 960 ft.
Water Surface
0
500 ft.
1000 ft.
1500 ft.
Section through Dam
Dam
Highway Bridge
0
1 Mi.
2 Mi.
Control and Topography by Flood Commission
Surveyed March 1910.


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
BLACK LICK CREEK RESERVOIR.
PROJECT No. 8
INDIANA COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Conemaugh R.
CAMPBELLS MILLS
GRAFTON
BLACK LICK
Pennsylvania R.R.
Indiana Br.
Two Lick Creek
B. R. & P. R.R.
Capacity 1455 Million Cubic Feet
Area 1333 Acres
Average Width 1037 Feet
" Depth 25 "
Flow Line Elev. 960 ft.
Water Surface
980
960
940
920
900
880
0
500 ft.
1000 ft.
1500 ft.
Section through Dam
CAMPBELLS MILLS
GRAFTON
BLACK LICK
Dam
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Railroad Bridge
Railroad Bridge
Flow Line Elev. 960 ft.
980
960
940
920
900
880
860
0
1 Mi.
2 Mi.
3 Mi.
4 Mi.
5 Mi.
6 Mi.
7 Mi.
8 Mi.
9 Mi.
10 Mi.
11 Mi.
Control and Topography by Flood Commission
Surveyed March 1910.


Allegheny River
B
860
840
820
800
780
760
740


Allegheny River
ROSSTON STA.
TUNNELTON
COCHRANS MILLS
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CROOKED CREEK RESERVOIR
PROJECT No. 4
ARMSTRONG COUNTY, PENN'A.
Capacity 3256 Million Cubic Feet
Area 1906 Acres
Average Width 1085 Feet
" Depth 39 "
Flow Line Elev 855 ft
Water Surface
500 ft
1000 ft
Section through Dam
Scale in Feet
1000 0 1000 2000 3000 4000 5000
TUNNELTON
COCHRANS MILLS
Dam
Highway Bridge
Fording
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Flow Line Elev 855 ft
860
840
820
800
780
760
740
Control and Topography by Flood Commission
Surveyed May 1910

Estimate of Cost.—(Continued.)

Land	$ 53,100
Buildings	64,300
Highways	25,900
Railroads	11,900
Bridges	48,600
Total	$ 626,500
Total, plus 15% for engineering and contingencies	720,500
Cost per million cubic feet of storage	495

CROOKED CREEK.

Crooked Creek rises in the northern half of Indiana County and flows in a westerly direction 54 miles, joining the Allegheny River 40.7 miles north of Pittsburgh, and 5 miles south of the town of Kittanning. The elevation of the source of the stream is about 1380 feet, and from here it falls at the rate of 11.6 feet per mile, entering the river at an elevation of 755 feet.

The drainage basin, having an area of 287 square miles, a length of 29 miles and an average width of 10 miles, drains portions of Indiana and Armstrong counties, and has a watershed of which the elevations along the crest range from about 1600 feet, at the head of the stream, to 1100 feet near the Allegheny River. Much of the main part of the valley is farmed, particularly in the lower stretches, and the topography of the bordering hills is less rugged than in the valleys to the north. About 24 per cent of the drainage area is under forest cover.

The discharge at the mouth varies between a maximum of 14,000 second-feet, or 48.8 second-feet per square mile, and a minimum of 1 second-foot, or 0.0035 second-foot per square mile. There is a difference of about 12 feet between high water and low water.

Reservoir Project. (4).

The formation is favorable for a reservoir of considerable capacity, with a dam only 0.2 of a mile from the Allegheny River, which enables complete control of the stream. The studies showed that the maximum capacity that could be economically obtained at this site was greater than that necessary for flood control, and the dam was accordingly reduced in height from 109 feet to 94 feet, making a reduction in capacity of 1,376,900,000 cubic feet. This excess capacity, if desired, could be constructed for navigation and power development purposes.

Another reservoir site, not surveyed, but studied largely from Geological Survey maps, is feasible, with the dam a short distance above Cochran's Mills, or something over a mile above the head of the chosen site. This location would probably have a larger storage capacity than the lower one.

The cultivation of the land in the section of the valley in question, while not of a particularly high grade, is better than anything obtaining in most of the valleys under consideration to the north, except French Creek. There are no prominent towns in the drainage basin and no railroad in the lower half of the valley, the only line of any importance within the watershed being a branch passing along the upper part of the stream.

The entire valley is in the productive coal measures, with the top member, the Upper Freeport coal, 3.5 feet thick, coming under the flow line of the proposed project for a distance of approximately 2¼ miles. The other coal beds of these strata are not considered to be of material value along this valley, and examination indicates that

they do not crop out in workable condition in the hillsides above the stream. Only the farmers of the locality mine the coal.

Important Features.

Drainage area above dam	287 sq. mi.
Capacity of reservoir	3,255,700,000 cu. ft.
Height dam above stream	94 feet
Length of crest	1,100 "
Elevation of crest	855 "
Length of reservoir	14.5 miles
Average width	1,085 feet
Average depth	39 "
Area of surface	1,906 acres

Property Involved.

Land below flow line, 1,706 acres; marginal strip, 190 acres; total, 1,896 acres (19% wooded).

Tunnelville: dwellings, 6; barns, 4; stores, 1; Grist mills, 1; power houses, 1; highway bridges, 2. In others parts of the valley are the following, which have been included in the estimate: dwellings, 28; barns, 26; schools, 2; churches, 1; power houses, 1; cemeteries, 1; ordinary highway, 8 miles; highway bridges, 4.

Estimate of Cost.

Dam		
Excavation	$ 18,100	
Concrete	538,100	
Riprap paving	3,500	
Gate house and appurtenances	35,000	
		$ 594,700
Land		85,900
Buildings		78,500
Highways		18,000
Total		$ 777,100
Total, plus 15% for engineering and contingencies		893,700
Cost per million cubic feet of storage		274

MAHONING CREEK.

Mahoning Creek has its main source in the western part of Clearfield County, flows southwestwardly to the northwestern corner of Indiana County, where it is joined by the Little Mahoning branch, and continues its course in a northwesterly direction, joining the Allegheny River, after flowing a total distance of 70 miles, at the village of Mahoning, situated 58.2 miles from Pittsburgh. From the opposing slope of the divide, at the headwaters, flows the West Branch of the Susquehanna. The elevation at a point 5 miles below the source is 1350 feet and at the mouth 786 feet, the fall between these two points averaging 8.7 feet per mile.

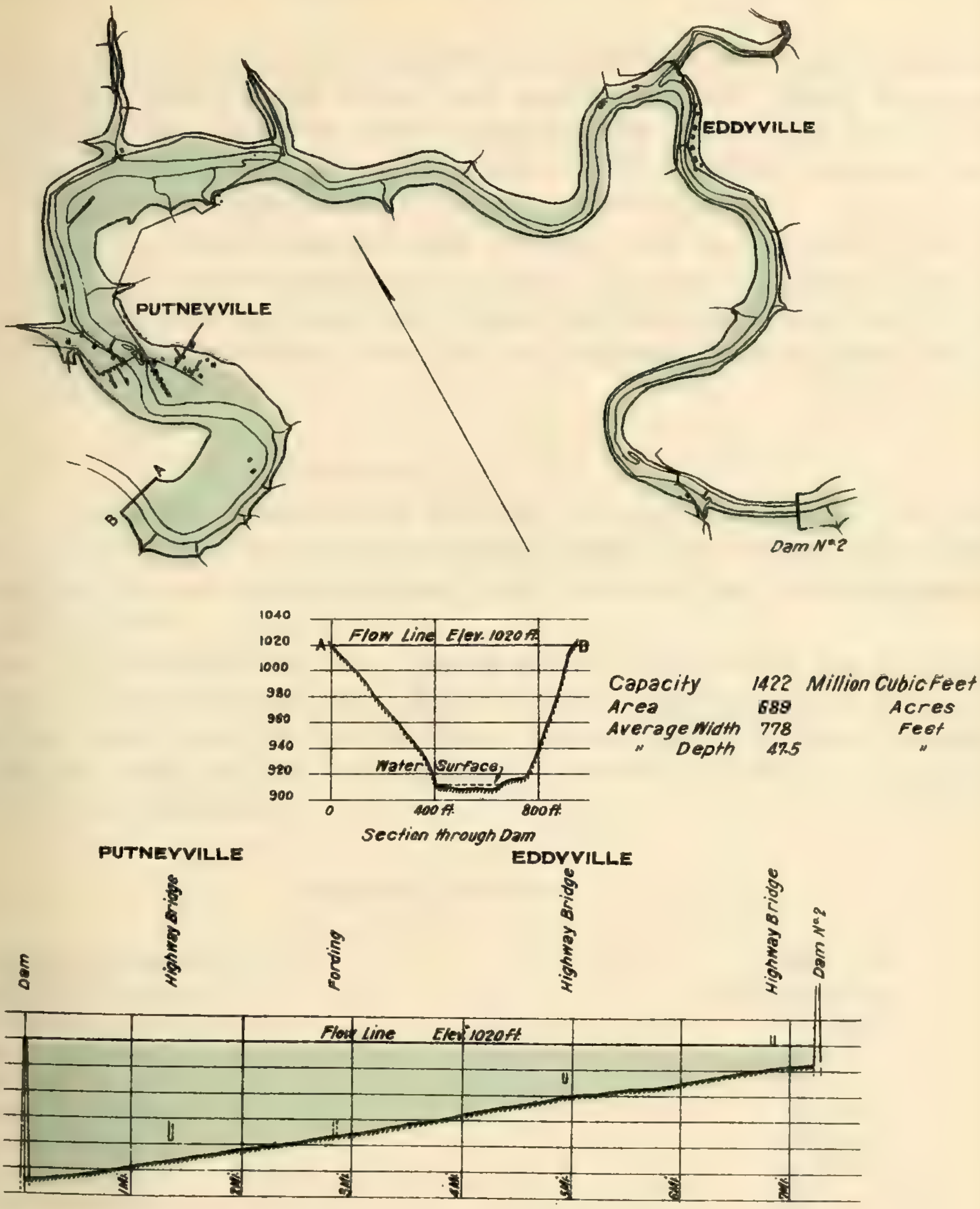
The drainage basin, which includes portions of Clearfield, Jefferson, Indiana and Armstrong counties, is fan-shaped, with an area of 417 square miles, a length of 42 miles and a width of 24 miles across the head, narrowing down to about 4 miles near the mouth. Along the Allegheny-Susquehanna divide the higher elevations range from 1600 to 2200 feet, gradually falling to about 1300 feet near the Allegheny River. About 31 per cent of the basin is wooded.

The discharge at the mouth reaches a maximum of 19,000 second-feet, or 45.5 second-feet per square mile, and drops to a minimum of 20 second-feet, or 0.049 second-

Mahoning Creek, Pa., October, 1910.
View down stream, showing crest of proposed Dam No. 1.

Mahoning Creek, Pa., February, 1911.
View down stream, from a point two miles east of Eddyville; flow line of proposed reservoir shown with dash line.

Mahoning Creek, Pa., February, 1911.
View up stream, from a point near McCrea's Furnace; flow lines of proposed reservoirs Nos. 1 and 2 shown with dash line.



FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED

MAHONING CREEK RESERVOIR — N°. 1

PROJECT N°. 5

ARMSTRONG COUNTY, PENN'A.

Scale in Feet
1000 0 1000 2000 3000

Control and Topography by Flood Commission.
Surveyed Mar. 1910

THE LORD BALTIMORE PRESS BALTO MD

foot per square mile. There is a difference of about 14 feet between high water and low water.

The upper part of the basin is more thickly populated than the lower portion, and the valleys have considerably more bottom land, mostly cultivated. Below the mouth of Little Mahoning, the immediate valley is thinly-settled, narrow and crooked, and the stream flows, for the greater part of the way to the Allegheny, between steep, brush-covered slopes, made rugged here and there by sandstone ledges.

A careful inspection made along the valley indicated that the physical formation from the mouth to about 30 miles above is advantageous for reservoir building, but the Pittsburgh & Shawmut Railroad, now being constructed on a grade too low for high dams, and held down by two tunnels, interferes with utilizing the first eleven miles of the stream, except at great cost.

Reservoir No. 1. (5).

The dam for this site would have its location 13.6 miles from the Allegheny River, in the lower portion of the horseshoe bend below the village of Putneyville, where, from the appearance of the stream bed, good rock foundation can be had throughout the whole length of dam.

The coals of the locality, at least those of any commercial value, are in the hills well above the flow line of this project. Practically all of the hamlets of Putneyville and Eddyville are under flow line, but the former could be moved to higher ground, a very short distance away, and the latter could be conveniently located on ground immediately back from the stream.

Important Features.

Drainage area above dam	385 sq. mi.
Capacity of reservoir	1,421,700,000 cu. ft.
Height dam above stream	108 feet
Length of crest	925 "
Elevation of crest	1,020 "
Length of reservoir	7.3 miles
Average width	778 feet
Average depth	47.5 "
Area of surface	689 acres

Property Involved.

Land below flow line, 451 acres; marginal strip, 99 acres; total, 550 acres (71% wooded).

Putneyville: dwellings, 28; barns, 3; schools, 1; churches, 1; stores, 2; grist mills, 1; cemeteries, 1; highway bridges, 1. Eddyville: dwellings, 9; barns, 1; churches, 1; stores, 1; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 8; barns, 3; ordinary highway, 3.8 miles, highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 21,000	
Concrete	568,600	
Riprap paving	4,500	
Gate house and appurtenances	39,500	
		$ 633,600

Estimate of Cost.—(Continued.)

Wall at Putneyville	$ 4,900
Land	20,800
Buildings	54,500
Highways	18,000
Bridges	15,900
Total	$ 747,700
Total, plus 15% for engineering and contingencies	859,900
Cost per million cubic feet of storage	605

Reservoir No. 2. (6).

The proposed site for the dam is in a narrow part of the valley, a short distance above old McCrea Furnace and 20.9 miles from the Allegheny River. In ascending the stream from the suggested dam to the hamlet of Milton, five miles above, one passes through a desolate part for most of the distance, between timber and brush-covered hills rising steeply from the water edges. At Milton the valley begins to open out, with farmed bottom land, much of which would be affected by the reservoir, as the water would back a considerable distance up both the main stream and the branch. Nearly a quarter of the village would come under flow line.

Important Features.

Drainage area above dam	335 sq. mi.
Capacity of reservoir	2,367,800,000 cu. ft.
Height dam above stream	143 feet
Length of crest	740 "
Elevation of crest	1,150 "
Length of reservoir	14.3 miles
Average width	645 feet
Average depth	35.0 "
Area of surface	1,554 acres

Property Involved.

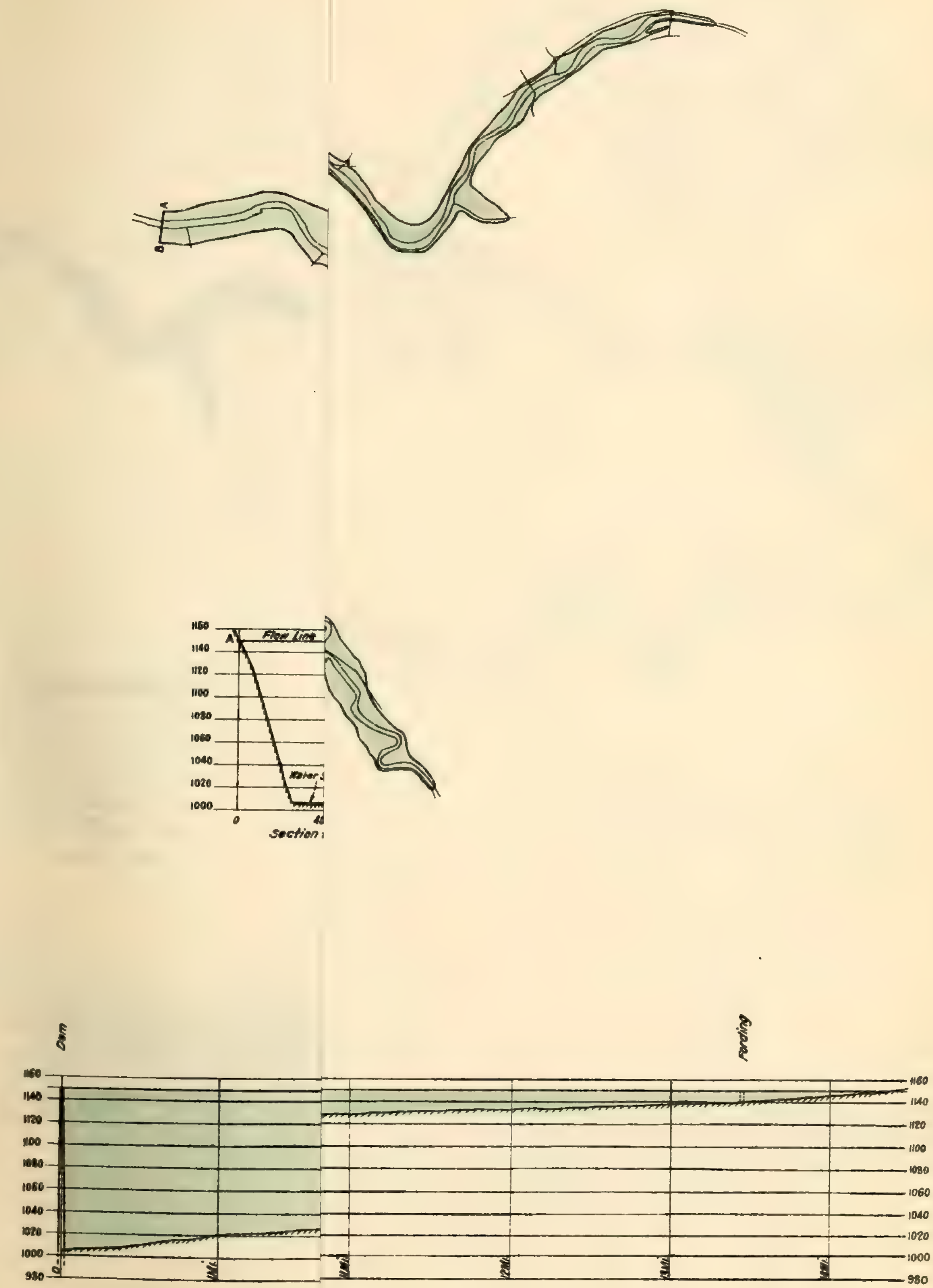
Land below flow line, 1,244 acres; marginal strip, 245 acres; total, 1,489 acres (50% wooded).

Milton: dwellings, 10; barns, 3; grist mills, 1; foundries, 1; highway bridges, 2. In other parts of the valley are the following, which have been included in the estimate: dwellings, 9; barns, 9; grist mills, 1; ordinary highway, 6.8 miles; highway bridges, 6.

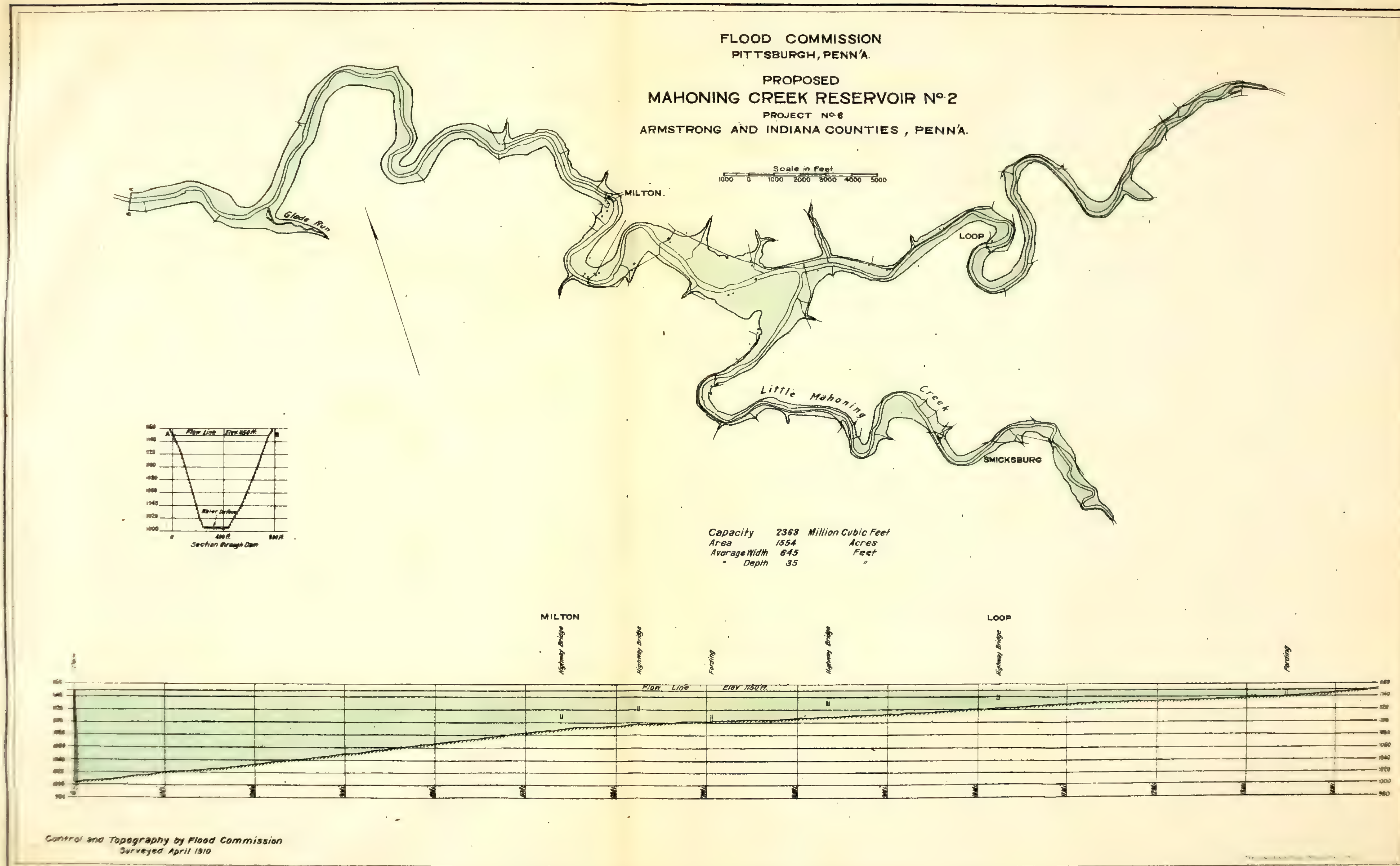
Estimate of Cost.

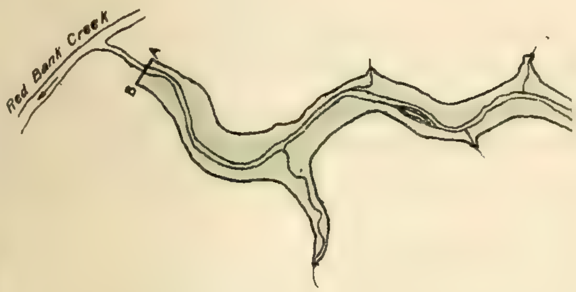
Dam		
Excavation	$ 19,600	
Concrete	709,600	
Riprap paving	3,100	
Gate house and appurtenances	38,700	
		$ 771,000
Land		29,000
Buildings		25,300
Highways		28,100
Bridges		93,900
Total		$ 947,300
Total, plus 15% for engineering and contingencies		1,089,400
Cost per million cubic feet of storage		460
Total capacity of two projects		3,789,500,000 cu. ft.
Total cost of two projects		$1,949,300

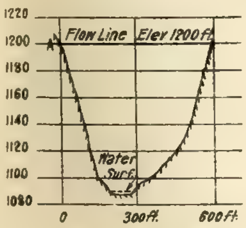
Mahoning Creek, Pa., October, 1910.
View up stream, showing crest of proposed Dam No. 2.



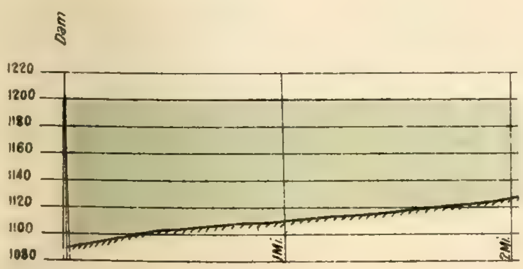
Control and Topography by Flood C
Surveyed April 1910


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
MAHONING CREEK RESERVOIR No. 2
PROJECT No. 6
ARMSTRONG AND INDIANA COUNTIES, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Glade Run
MILTON.
LOOP
Little Mahoning Creek
SMICKSBURG
Flow Line
Elev 1150 ft.
Water Surface
Section through Dam
Capacity 2368 Million Cubic Feet
Area 1554 Acres
Average Width 645 Feet
" Depth 35 "
MILTON
LOOP
Highway Bridge
Highway Bridge
Fording
Highway Bridge
Highway Bridge
Fording
Flow Line Elev 1150 ft.
Control and Topography by Flood Commission
Surveyed April 1910

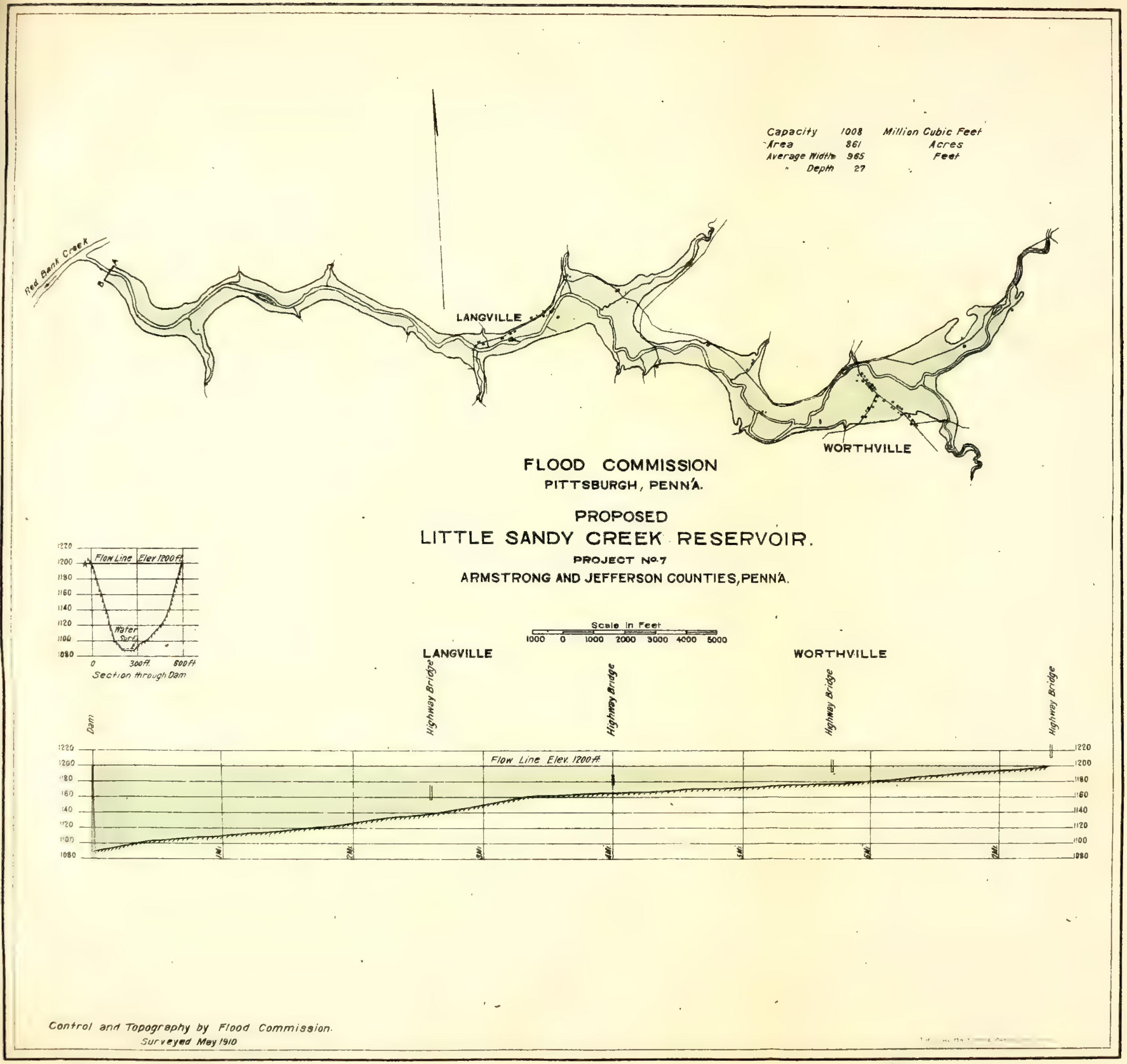




Section through Dam.



Control and Topography by Flood Commission.
Surveyed May 1910.


Capacity 1008 Million Cubic Feet
Area 861 Acres
Average Width 965 Feet
" Depth 27
Red Bank Creek
LANGVILLE
WORTHVILLE
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
LITTLE SANDY CREEK RESERVOIR.
PROJECT No. 7
ARMSTRONG AND JEFFERSON COUNTIES, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line Elev. 1200 ft.
Water Surf.
0 300 ft. 600 ft.
Section through Dam
LANGVILLE
WORTHVILLE
Dam
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Flow Line Elev. 1200 ft.
1220
1200
1180
1160
1140
1120
1100
1080
1 Mi.
2 Mi.
3 Mi.
4 Mi.
5 Mi.
6 Mi.
7 Mi.
Control and Topography by Flood Commission.
Surveyed May 1910

LITTLE SANDY CREEK.

Little Sandy, a branch of Red Bank Creek, rises in the southern part of Jefferson County and flows due west 17 miles to its junction with the Red Bank, 26 miles from the Allegheny River. In the lower 7 miles of the stream the fall to the mouth, where the elevation is 1085 feet, is 16.4 feet per mile. Practically all the drainage basin, an area of 79 square miles, lies within Jefferson County. On the lower reaches the hills bordering the stream are high and the valley is narrow. A considerable quantity of second-growth, middle-sized timber covers the slopes below Worthville and in this section there is practically no farm land. About 38 per cent of the drainage area is under forest cover.

From a point a short distance above the Red Bank, the bed of the stream is, geologically, above the red shale, and in the vicinity of Worthville it cuts through the lower portion of the productive coal measures. Judging from available data and reconnoissance in the valley, there are no coals of value which would be affected by reservoiring. Below Worthville the valley is practically uninhabited.

Reservoir Project. (7).

The topography being favorable, the location determined upon for the dam was 0.1 of a mile from the mouth of the stream. An inspection of the locality indicates that rock foundation obtains at a slight depth below the ground surface.

Important Features.

Drainage area above dam	78 sq. mi.
Capacity of reservoir	1,007,500,000 cu. ft.
Height dam above stream	111 feet
Length of crest	590 "
Elevation of crest	1,200 "
Length of reservoir	7.4 miles
Average width	965 feet
Average depth	27.0 "
Area of surface	861 acres

Property Involved.

Land below flow line, 786 acres; marginal strip, 114 acres; total, 900 acres (24% wooded).

Langville: dwellings, 9; barns, 3; blacksmith shops, 1; grist mills, 1; woolen mills, 1; boiler houses, 1; highway bridges, 1. Worthville: dwellings, 20; barns, 6; schools, 1; churches, 1; stores, 1; highway bridges, 2. In other parts of the valley are the following, which have been included in the estimate: dwellings, 12; barns, 9; saw mills, 1; ordinary highway, 3.4 miles; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 17,000	
Concrete	388,800	
Riprap paving	2,000	
Gate house and appurtenances	13,500	
		$ 421,300
Land		29,400
Buildings		48,000
Highways		13,100
Total		$ 511,800
Total, plus 15% for engineering and contingencies		588,600
Cost per million cubic feet of storage		584

NORTH BRANCH RED BANK CREEK.

This stream rises in the northeastern part of Jefferson County and flows a distance of 20 miles in a southwesterly direction, joining Red Bank Creek at the town of Brookville, 43 miles from the Allegheny River. The drainage area above the mouth, where the elevation is 1205 feet, is 102 square miles, of which 66 per cent is wooded.

A topographical survey of this stream was not made, but an examination of the valley and a line of levels indicated that the physical features were well adapted for a reservoir of considerable capacity, with the dam located about 1.5 miles above the mouth of the stream. The lower reaches of the valley, since the lumber days, have been abandoned, the tracks of the lumber railroad removed and the slopes are now covered with a growth of small timber. There are no habitations of any importance that would be involved by a reservoir project.

Reservoir Project. (8).

The estimated height of the dam is 83 feet, flow line elevation 1300 feet, length of reservoir 5.0 miles and capacity 1,350,000,000 cubic feet.

Estimate of Cost.

Dam and appurtenances	$405,000	
Land and damages	28,900	
		$ 433,900
Total, plus 15% for engineering and contingencies		499,000
Cost per million cubic feet of storage		369

CLARION RIVER.

The Clarion River, from its source in the southern part of McKean County, 18 miles south of the New York state line, flows 107 miles in a generally straight southwesterly direction, joining the Allegheny River 86.1 miles from Pittsburgh, near the town of Parker. It is the second longest tributary of the Allegheny and the third largest in drainage area. It is notable that from the mouth to Hallton, a distance of 72 miles, or over half its length, there is no railroad and only two hamlets of any importance along its banks, the towns of Clarion, Callensburg and St. Petersburg being on high ground, 450, 150 and 470 feet, respectively, above the stream. From Johnsonburg to the mouth, water elevation 1421 and 851 feet respectively, the fall per mile is as follows: Johnsonburg to Hallton, 15 miles, 11.2 feet; Hallton to Cathers Run, 26 miles, 4.6 feet; Cathers Run to mouth, 45.7 miles, 6.2 feet.

The drainage basin, which has an area of 1213 square miles, and the general shape of a parallelogram, with a greatest length of 72 miles, and an average width of about 17 miles, includes portions of McKean, Forest, Jefferson, Elk and Clarion counties. About 63 per cent of the basin, mostly in the upper portion, is under forest cover, which includes several tracts of virgin timber, aggregating an area of about 30 square miles. A very considerable area has been burned over, amounting, in the aggregate, to about 240 square miles, or about 31 per cent of the total wooded area of 762 square miles.

The elevations of the ridges range from 2200 at the head of the basin, near Mt. Jewett, to about 1200 feet near the lower end. Much of the region, particularly bordering the streams, is steep, and should give a high rate of run-off at times of heavy precipitation.

The discharge from the drainage area of 910 square miles at Clarion, 31.3 miles

Little Sandy Creek, Pa., October, 1910.
View up stream, showing crest of proposed dam. Red Bank Creek in foreground.

North Branch Red Bank Creek, Pa., October, 1910.
View up stream, showing crest of proposed dam.

above the mouth, varies between a maximum of 39,300 second-feet, or 43.1 second-feet per square mile, and a minimum of 50 second-feet, or 0.055 second-foot per square mile. The variation between high and low water is about 17 feet.

A few miles below Cathers Run, owing to the general northerly or northeasterly rise of the rock strata, the red shale appears above water surface and continues above, with the coal measures overlying, throughout most of the upper Clarion and tributaries. This stream enters the northern edge of the coal bearing field and cuts deeply into the lower members of the formation, remaining, however, far below coal beds of any value, which are in small areas on high knobs, back from the stream. Near the Allegheny River, an oil field crosses, with a number of wells of small production on the banks of the stream.

Until a comparatively recent date, the Clarion was one of the most active tributaries in the lumber business, and thousands of craft and boat bottoms have floated from its shores. Since the cutting of the large forests, however, the business has decreased to a very small amount. Only a second-growth of mixed timber remains along the immediate valley, and this in comparatively small amount on the rugged slopes, except at Cooksburg, where an area of several thousand acres of virgin pine and hemlock touches the north bank of the stream.

The principal towns along the valley and their respective populations are as follows: Johnsonburg, 4340; Ridgway, 5410; Clarion, 2620; Callensburg, 200.

The Clarion, from the mouth to Hallton, offers excellent opportunities for reservoiring on a large scale and at comparatively small construction cost. The average slope is 5.6 feet per mile, the hills are steep and barren of development and here and there stand away from the stream enough to add considerably to storage capacity.

The examination disclosed the feasibility of four sites, three of which were surveyed, namely, Nos. 1, 3 and 4, located above the mouth of the stream respectively as follows: 1, 0.3 mile; 3, 35.9 miles, at Mill Creek, 3.5 miles northeast of Clarion; 4, 58.6 miles, 1.5 miles above Clarington.

The possibility of site No. 2 was ascertained at the time of the general examination of this valley and from the United States Geological Survey map, which covers the stream below the vicinity of Clarion. It has not been included in the studies for flood control, as the combined capacities of the other three sites are adequate for this purpose; but, if constructed, the additional storage would supply water for navigation assistance and for power development either at this or at any other of the dams on the Clarion. The site found favorable for the dam is at a point 22.5 miles from the mouth, or 1.4 miles below the head of natural backwater of No. 1, which would cause a depth of water of 8 feet at the lower face of the dam. The dimensions of the dam and quantities were determined from the surveys of the Commission, but the capacity and area of the reservoir were derived from the government map.

Inspection of the bed of the stream at each of the dam sites indicated that solid rock foundation could be reached at or slightly below stream bed.

Reservoir No. 1. (9).

On this part of the stream the valley is narrow and gorge-like, with very little bottom land, the steeply ascending hills being well covered with second-growth timber and holding at intervals sandstone and shale ledges. In the oil field, crossing a short distance above the mouth of the stream, about 50 wells, now of small production, would come below the flow line.

Important Features.

Drainage area above dam	1,212 sq. mi.
Capacity of reservoir	5,067,000,000 cu. ft.
Height dam above stream	142 feet
Length of crest	880 "
Elevation of crest	1,000 "
Length of reservoir	23.6 miles
Average width	708 feet
Average depth	57.5 "
Area of surface	2,024 acres

Property Involved.

Land below flow line, 1,160 acres; marginal strip, 323 acres; total, 1,483 acres (85% wooded).

There are no settlements of importance affected by this project. Scattered along the valley there are the following, which have been included in the estimate: dwellings, 20; barns, 9; grist mills, 1; saw mills, 2; boiler houses, 10; oil wells, 50; highway bridges, 4; ordinary highway, 12.2 miles.

Estimate of Cost.

Dam		
Excavation	$ 19,700	
Concrete	967,100	
Riprap paving	3,800	
Gate house and appurtenances	51,500	
		$1,042,100
Land		19,600
Buildings		27,300
Highways		9,500
Bridges		40,600
Total		$1,139,100
Total, plus 15% for engineering and contingencies		1,309,900
Cost per million cubic feet of storage		258

Reservoir No. 2. (9-A).*

Important Features.

Drainage area above dam	1,079 sq. mi.
Capacity of reservoir	1,930,500,000 cu. ft.
Height dam above stream	89 feet
Length of crest	555 "
Elevation of crest	1,080 "
Length of reservoir	13.4 miles.
Average width	709 feet
Average depth	38.5 "
Area of surface	1,152 acres

Property Involved.

Land below flow line, 803 acres; marginal strip, 170 acres; total, 973 acres (85% wooded).

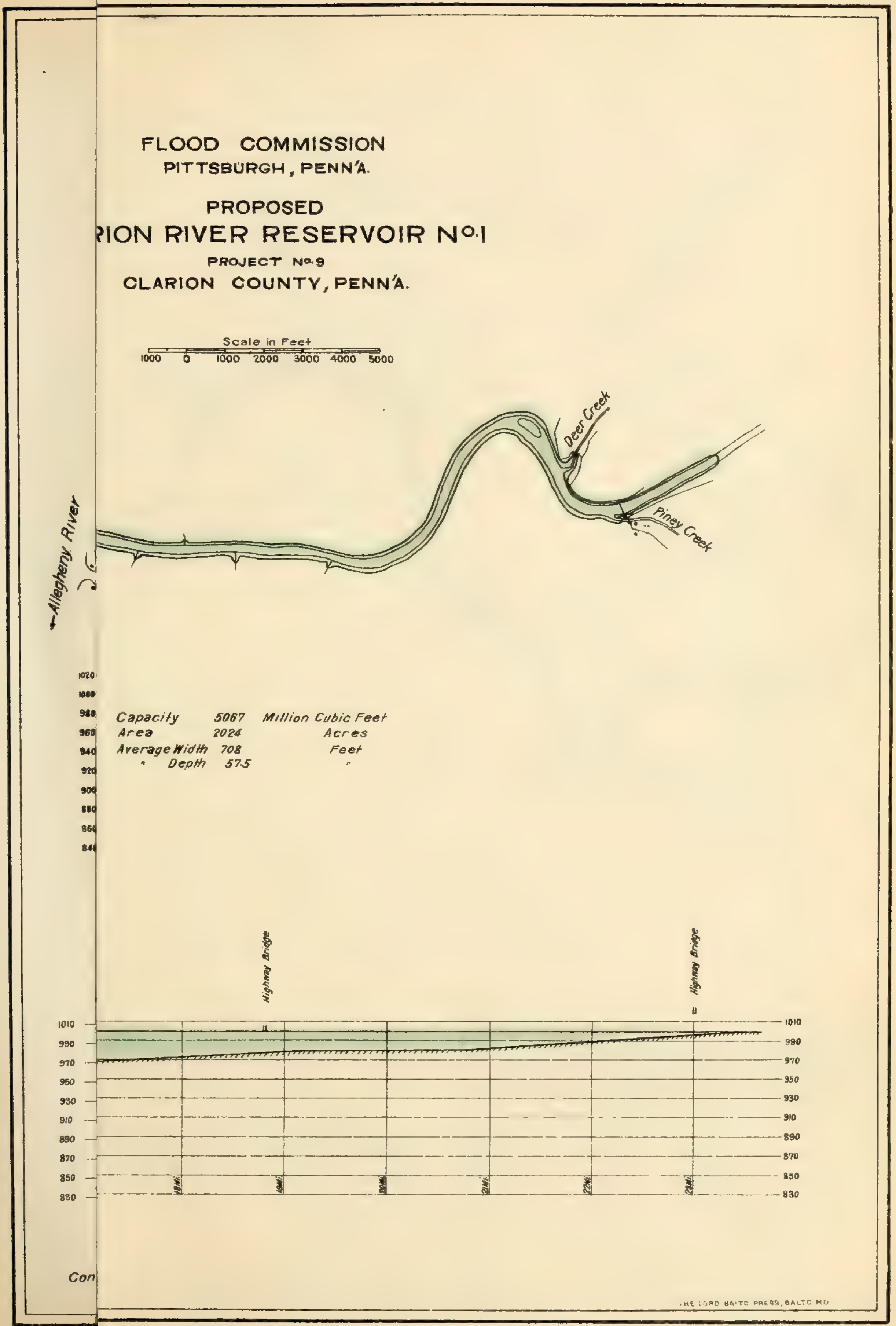
Estimate of Cost.

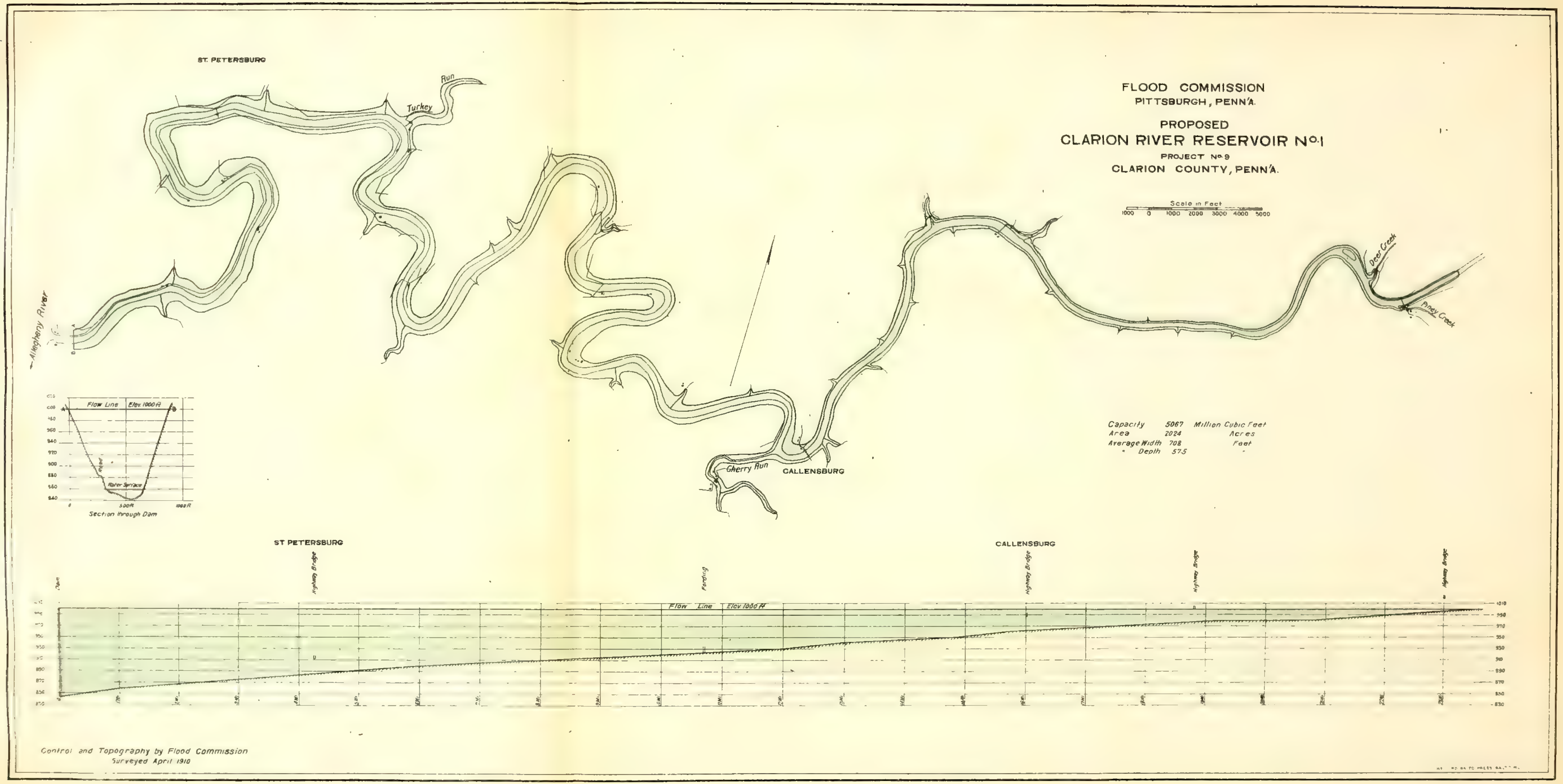
Dam		
Excavation	$ 12,300	
Concrete	330,700	
Riprap paving	3,600	
Gate house and appurtenances	32,000	
		$ 378,600

*This project not considered as one of the 43 for flood control.

Clarion River, Pa., October, 1910.
View up stream, showing crest of proposed Dam No. 1.

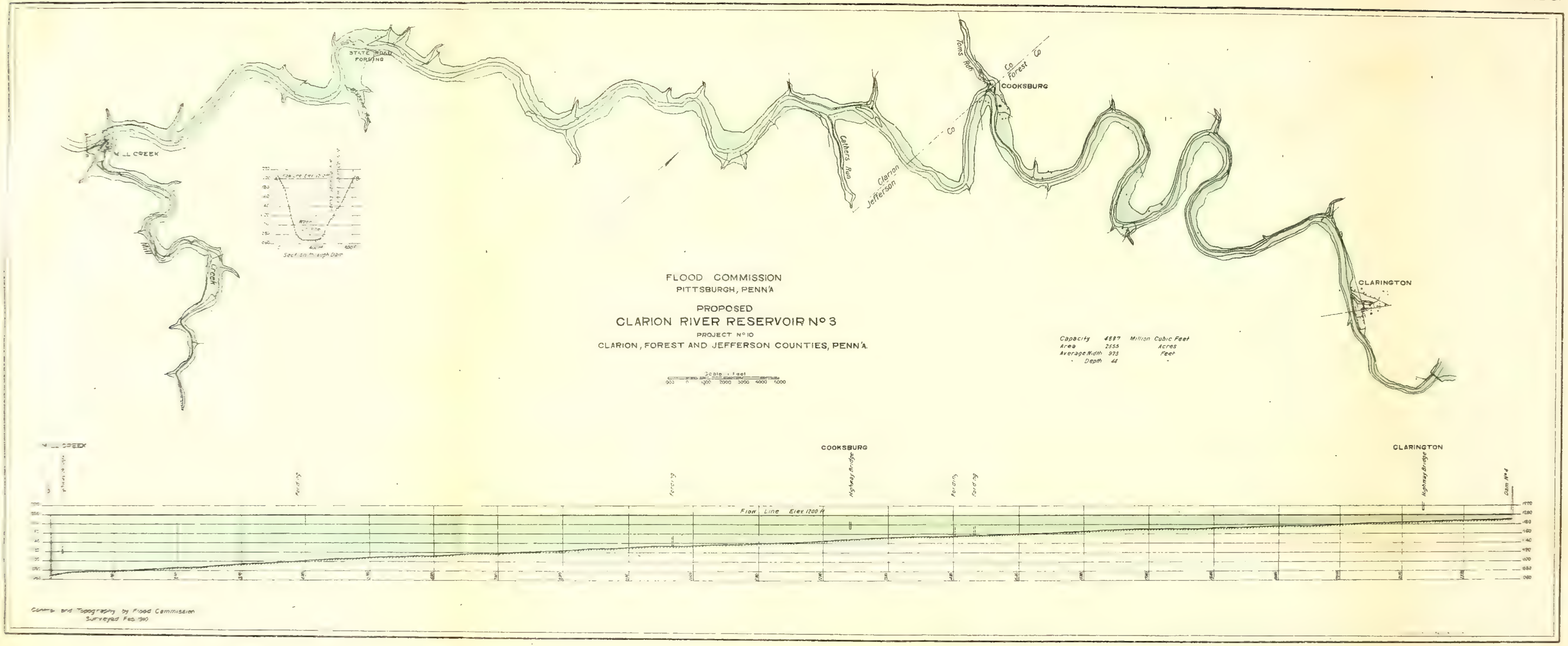
PLATE 26


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
RION RIVER RESERVOIR No. 1
PROJECT No. 9
CLARION COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Deer Creek
Piney Creek
Allegheny River
Capacity 5067 Million Cubic Feet
Area 2024 Acres
Average Width 708 Feet
" Depth 57.5 "
Highway Bridge
Highway Bridge
1010
990
970
950
930
910
890
870
850
830
18 Mi.
19 Mi.
20 Mi.
21 Mi.
22 Mi.
23 Mi.
Con
THE LORD BALTO PRESS, BALTO MD



FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CLARION RIVER RESERVOIR No.1
PROJECT No.9
CLARION COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
ST. PETERSBURG
Turkey Run
Allegheny River
Cherry Run
CALLENSBURG
Deer Creek
Piney Creek
Capacity 5067 Million Cubic Feet
Area 2024 Acres
Average Width 708 Feet
" Depth 57.5 "
Flow Line Elev 1000 ft
Section through Dam
ST PETERSBURG
CALLENSBURG
Dam
Highway Bridge
Fording
Highway Bridge
Highway Bridge
Highway Bridge
Flow Line Elev 1000 ft
Control and Topography by Flood Commission
Surveyed April 1910

Clarion River, Pa., October, 1910.
View down stream, showing crest of proposed Dam No. 3.


FLOOD COMMISSION
PITTSBURGH, PENN'A
PROPOSED
CLARION RIVER RESERVOIR Nº 3
PROJECT Nº 10
CLARION, FOREST AND JEFFERSON COUNTIES, PENN'A
Scale - Feet
1000 0 1000 2000 3000 4000 5000
Capacity 4887 Million Cubic Feet
Area 2555 Acres
Average Width 973 Feet
" Depth 44 "
STATE ROAD FORDING
COOKSBURG
CLARINGTON
Toms Run
Forest Co
Cathers Run
Clarion Co
Jefferson Co
Mill Creek
Section through Dam
Flow Line Elev 1200 ft
Highway Bridge
Fording
Dam Nº 4
Contours and Topography by Flood Commission
Surveyed Feb. 1911

Estimate of Cost.—(Continued.)

Land	$ 20,100
Buildings	17,700
Highways	18,600
Bridges	38,000
Total	$ 473,000
Total, plus 15% for engineering and contingencies	543,900
Cost per million cubic feet of storage	282

RESERVOIR NO. 3. (10).

The selected point for this dam is just below the mouth of Mill Creek, an important tributary entering on the left bank. From this stream a saw mill of considerable capacity, located on its bank near the mouth, receives most of its timber. It is expected that the large timber will be exhausted in about two years and the plant abandoned. The estimates, however, include damages for a portion of the lumber railroad, and several hundred feet of branch line, which extends five miles from the lumber settlement to Strattonville, connecting there with the Pittsburgh, Summerville & Clarion Railroad. The cost of this reservoir per million cubic feet of storage is the lowest of any of the projects on the Allegheny Basin.

Important Features.

Drainage area above dam	874 sq. mi.
Capacity of reservoir	4,886,600,000 cu. ft.
Height dam above stream	128 feet
Length of crest	800 "
Elevation of crest	1,200 "
Length of reservoir	22.7 miles
Average width	928 feet
Average depth	44 "
Area of surface	2,555 acres

Property Involved.

Land below flow line, 1,843 acres; marginal strip, 373 acres; total, 2,216 acres (77% wooded).

Mill Creek: dwellings, 12; barns, 4; stores, 1; saw mills, 1; highway bridges, 1. Cooksburg: dwellings, 15; barns, 11; schools, 1; stores, 1; highway bridges, 1; hotels, 1. Clarington: dwellings, 20; barns, 8; highway bridges, 1 (not affected); stores, 2; hotels, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 31; barns, 16; saw mills, 5 (2 in operation); churches, 1.

Estimate of Cost.

Dam		
Excavation	$ 12,800	
Concrete	608,300	
Riprap paving	3,200	
Gate house and appurtenances	41,000	
		$ 665,300
Land		40,900
Buildings		96,100
Highways		12,200
Bridges		79,500
Total		$ 894,000
Total, plus 15% for engineering and contingencies		1,028,100
Cost per million cubic feet of storage		210

Reservoir No. 4. (11).

A short distance below the site of this dam the valley widens out, on the right bank, into a broad flat, upon which is located the village of Clarington. This place was at one time quite active in the lumber business, but in recent years has lost some of its population. Just above the site of the dam, on the left bank, enters Clear Creek, an important tributary of the Clarion. The main valley, all the way to Hallton, is thinly settled, there being only one place worthy of note, a lumber settlement called Millstone, where it is understood that the saw mill is about to be abandoned. This is the only one of the Clarion River projects through which a highway runs for its whole length.

Important Features.

Drainage area above dam	724 sq. mi.
Capacity of reservoir	1,537,900,000 cu. ft.
Height of dam above stream	70 feet
Length of crest	880 "
Elevation of crest	1,260 "
Length of reservoir	14.1 miles
Average width	711 feet
Average depth	29 "
Area of surface	1,219 acres

Property Involved.

Land below flow line, 825 acres; marginal strip, 221 acres; total, 1,046 acres (73% wooded).

Millstone Creek: dwellings, 5; barns, 4. Millstone: dwellings, 18; barns, 7; schools, 1; stores, 1; saw mills, 1; highway bridges, 1. Hallton: dwellings, 20; barns, 5. In other parts of the valley are the following, which have been included in the estimate: dwellings, 16; barns, 16; boiler houses, 2; ordinary highway, 16 miles.

Estimate of Cost.

Dam		
Excavation	$ 11,600	
Concrete	286,800	
Riprap paving	3,600	
Gate house and appurtenances	24,000	
		$ 326,000
Land		9,400
Buildings		21,500
Highways		4,300
Bridges		31,700
Total		$ 392,900
Total, plus 15% for engineering and contingencies		451,800
Cost per million cubic feet of storage		294
Total capacity of projects Nos. 1, 3 and 4		11,491,500,000 cu. ft.
Total cost of projects Nos. 1, 3 and 4		$ 2,789,800

EAST SANDY CREEK.

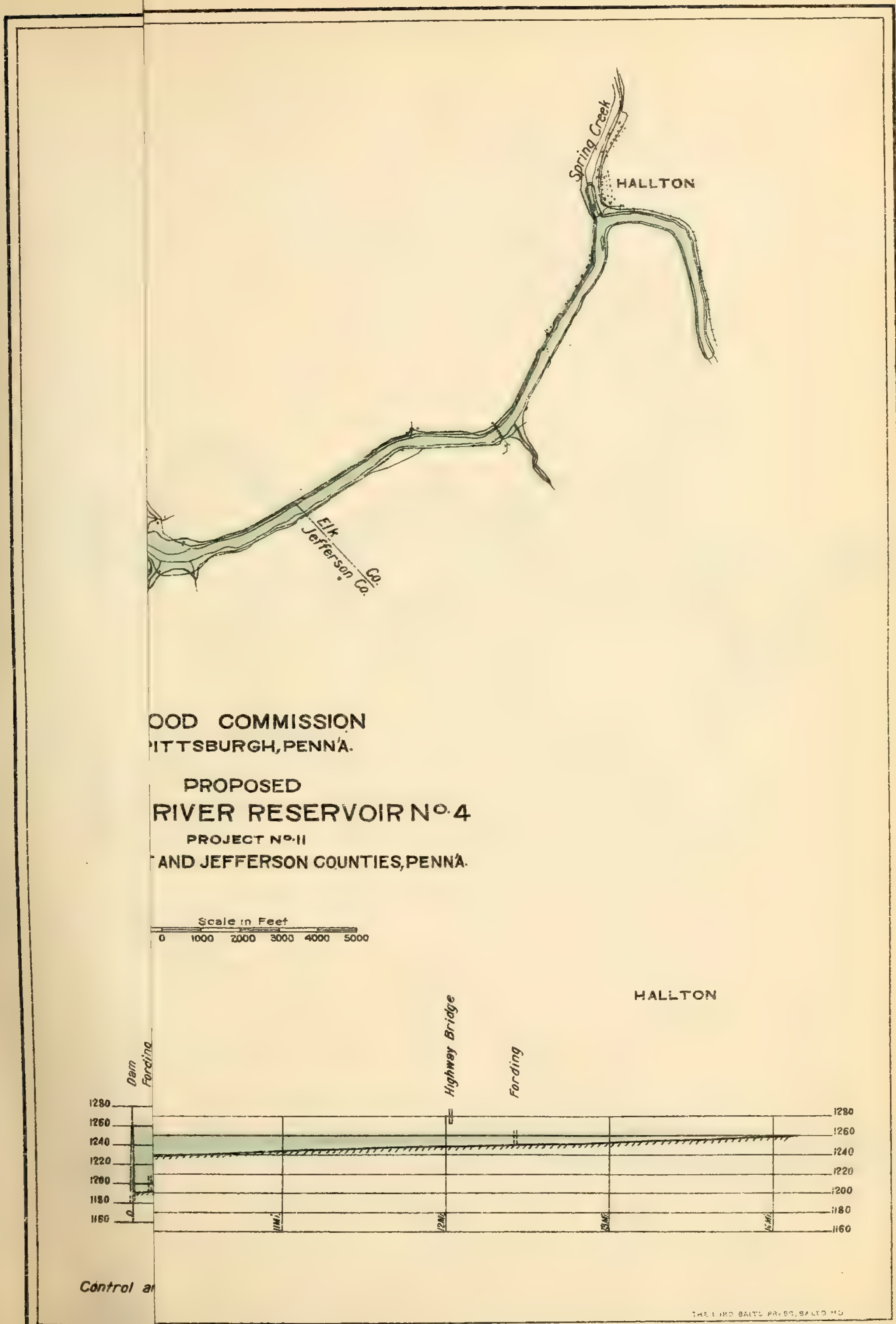
East Sandy Creek rises in the northwestern part of Clarion County and flows a distance of 23 miles through a very sparsely settled valley, entering the Allegheny on the left bank 121.1 miles from Pittsburgh and 5.5 miles south of Franklin. From a point 9 miles above the mouth, the stream has a fall of 31.1 feet per mile to the mouth, where the elevation is 943 feet. The drainage basin, which lies mostly in the southeastern part of Venango County, has an area of 104 square miles, the topography of which is rugged and the valley generally narrow. About 64 per cent of the basin is

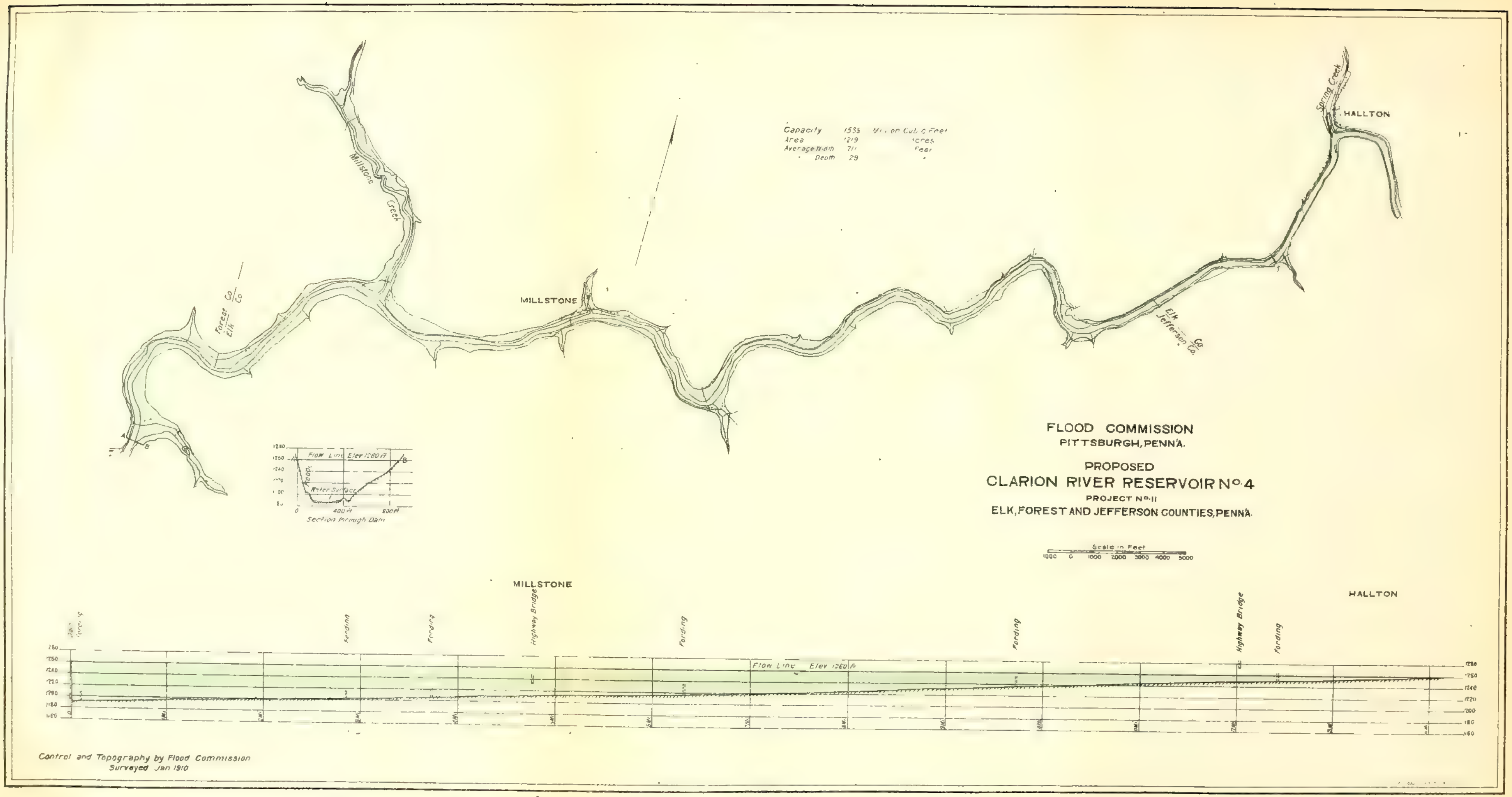
Clarion River, Pa., October, 1910.
View of the village of Cooksburg.

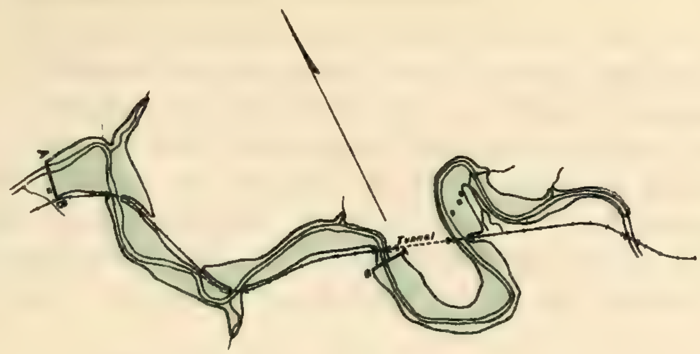
Clarion River, Pa., October, 1910.
View up stream, showing crest of proposed Dam No. 4.

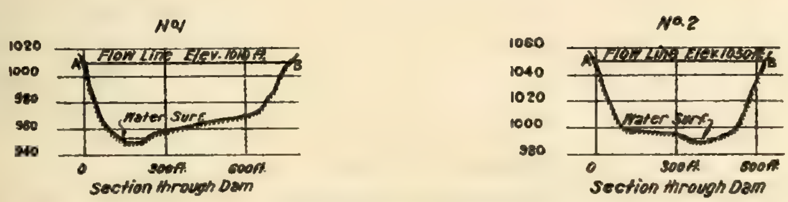
CLARION RIVER, PA., OCTOBER, 1910.
View down stream, from a point 2.1 miles above Clarington; crest of proposed Dam No. 4 shown in the distance.

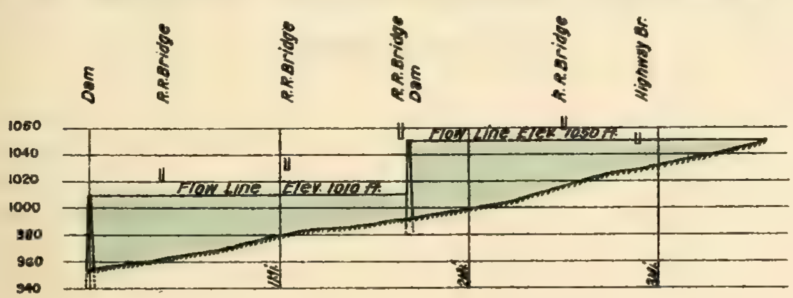
CLARION RIVER, PA., OCTOBER, 1910.
View up stream, from a point 2.1 miles above Clarington; flow line of proposed reservoir No. 4 shown with dash line.


Spring Creek
HALLTON
Elk Co.
Jefferson Co.
OOD COMMISSION
ITTSBURGH, PENN'A.
PROPOSED
RIVER RESERVOIR No. 4
PROJECT No. 11
T AND JEFFERSON COUNTIES, PENN'A.
Scale in Feet
0 1000 2000 3000 4000 5000
HALLTON
Dam
Fording
Highway Bridge
Fording
1280
1260
1240
1220
1200
1180
1160
11 MI.
12 MI.
13 MI.
14 MI.
Control a


Capacity 1535 Million Cubic Feet
Area 1219 Acres
Average Width 711 Feet
Depth 29
Millstone Creek
Spring Creek
HALLTON
MILLSTONE
Forest Co.
Elk Co.
Elk Co.
Jefferson Co.
Flow Line Elev 1260 ft
Water Surface
400 ft
800 ft
Section through Dam
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CLARION RIVER RESERVOIR No. 4
PROJECT No. 11
ELK, FOREST AND JEFFERSON COUNTIES, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
MILLSTONE
HALLTON
Fording
Highway Bridge
Fording
Fording
Highway Bridge
Fording
Flow Line Elev 1260 ft
Control and Topography by Flood Commission
Surveyed Jan 1910







	No. 1	No. 2
Capacity in Million Cubic Feet	138	102
Area in Acres	113	91
Average Width in Feet	553	405
" Depth " "	28.0	25.5

FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED
EAST SANDY CREEK RESERVOIRS Nos. 1 AND 2
PROJECTS 12 AND 13
VENANGO COUNTY, PENN'A.

Scale in Feet
1000 0 1000 2000 3000

Control and Topography by Flood Commission
Surveyed June 1910

The Lord Baltimore Press Balto Md

under forest cover. Probably 10 miles of the lower part of the stream bed lies below the red shale, with the conglomerate well up on the hillsides.

On account of the steep slope of the stream, and the fact that the Franklin & Clearfield Railroad, a line affiliated with the New York Central, crosses the stream five times in the section proposed for reservoirs, it is difficult to secure favorable sites. As the railroad is fully 60 feet above stream, however, two sites, both of small capacity, were considered feasible, the dam for the lower one being 0.6 of a mile and for the upper one, 2.3 miles from the mouth. At both sites it is considered that rock foundations are readily obtainable. It is to be noted that the cost of the upper reservoir per million cubic feet of storage is the greatest of all the projects under consideration.

Reservoir No. 1. (12).

Important Features.

Drainage area above dam	103 sq. mi.
Capacity of reservoir	137,700,000 cu. ft.
Height dam above stream	55 feet
Length of crest	755 "
Elevation of crest	1,010 "
Length of reservoir	1.7 miles
Average width	553 feet
Average depth	28.0 "
Area of surface	113 acres

Property Involved.

Land below flow line, 93 acres; marginal strip, 25 acres; total, 118 acres (57% wooded).

Estimate of Cost.

Dam		
Excavation	$ 13,500	
Concrete	226,200	
Riprap paving	4,300	
Gate house and appurtenances	15,700	
		$ 259,700
Land		3,400
Total		$ 263,100
Total, plus 15% for engineering and contingencies		302,500
Cost per million cubic feet of storage		2,197

Reservoir No. 2. (13).

Important Features.

Drainage area above dam	96 sq. mi.
Capacity of reservoir	102,100,000 cu. ft.
Height dam above stream	57 feet
Length of crest	620 "
Elevation of crest	1,050 "
Length of reservoir	1.9 miles
Average width	405 feet
Average depth	25.5 "
Area of surface	91 acres

Property Involved.

Land below flow line, 78 acres; marginal strip, 22 acres; total, 100 acres (73% wooded).

In the valley are the following, which have been included in the estimate: dwellings, 2; saw mills, 1; ordinary highway, 0.1 mile; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 9,100	
Concrete	191,500	
Riprap paving	2,100	
Gate house and appurtenances	17,300	
		$ 220,000
Land		1,100
Buildings		4,400
Highways		6,300
Total		$ 231,800
Total, plus 15% for engineering and contingencies		266,600
Cost per million cubic feet of storage		2,611
Total capacity of two projects		239,800,000 cu. ft.
Total cost of two projects		$ 569,100

FRENCH CREEK.

French Creek, which as a tributary of the Allegheny ranks second in area of drainage basin and third in length of stream, rises in the southwestern corner of New York State, six miles west of Lake Chautauqua, and after flowing a distance of 23 miles, enters the State of Pennsylvania, through which it flows 75 miles, joining the Allegheny at the city of Franklin, on the right bank, 126.6 miles from Pittsburgh. The stream rises at an elevation of 1740 feet above sea, 432 feet higher than Lake Chautauqua, has an average fall per mile of 8.0 feet in its length of 98 miles and enters the Allegheny at an elevation of 959 feet. The rate of fall per mile from Le Boeuff, 62 miles from the mouth, is only 3.8 feet.

The drainage basin, shaped much like a crescent, has a length of 70 miles, an average width of 17.7 miles and an area of 1238 square miles. It includes most of Erie and Crawford counties, and also drains a small part of Venango and Mercer counties, Pennsylvania, and of Chautauqua County, New York. The divide on the north, paralleling the Lake Erie escarpment, at one place about four miles distant from the lake edge, has elevations ranging from about 1250 feet in the western part of Erie County to 1800 feet in New York State, gradually decreasing southwardly to 1400 and 1500 feet along the eastern edge.

The notable feature of this basin is that, with the exception of a small part of the lower end, it lies within the glaciated region. The terminal moraine, which is composed of sand and rounded stones, sometimes in hills of considerable size, marks the southern limit of the ice field which once covered the region to the north. The moraine crosses the valley a short distance below Utica, and northwardly from there follows, in a general course, the lower reaches of Sugar Creek branch, leaving the basin near the Venango-Crawford county line. The drift deposited by the melting ice of the glacier has filled over many parts of the basin to considerable depth. This formation, it has been thought, stores large quantities of water and doubtless tends to have a regulating effect upon the flow; but the gaging stations of the Flood Commission on this stream, while they have been in operation long enough to arrive at fairly accurate results as to the amount of water passing down the channel at various heights, do not as yet furnish sufficient data to measure the relative effect of the geological formation on the run-off. It is supposed that this vast underground storage acts much the same as would an artificial reservoir, collecting and holding a portion of the rains of the wet season and giving out this impounded water to the stream during the dry season.

The maximum discharge at Carlton, 13.7 miles above the mouth, from a drainage area of 1070 square miles, is 48,700 second-feet, or 45.5 second-feet per square mile, and the minimum, 50-second-feet, or 0.047 second-foot per square mile. The variation between high and low water stages is about 16 feet.

The rock formation of the valley is shale, interspersed with layers of sandstone, above which lies a heavy sandstone bed, portions of which, not having been ground off by the glacier, remain on the higher elevations.

About half a dozen glacial lakes are scattered over the drainage basin, located at or near the heads of southerly flowing tributaries. The two principal lakes are Conneaut, in the western part of Crawford County, elevation 1072 feet, and Finleys in New York State, elevation 1421 feet. The former lake is at the northern edge of a glacial swamp, at a few feet higher elevation, and is situated very near the western divide, which on this side is low and rolling. A short distance to the west, beyond the divide, is the large Pymatuning Swamp, at an average elevation of about 1010 feet. The drift formation in this swamp, judging from drill holes in the vicinity, must be, in places, nearly 100 feet in depth. About 20 per cent of the drainage basin is wooded and a considerable part of the remainder is under cultivation, some of it to a high degree.

The principal towns along the valley, and their respective populations, are as follows: Wattsburg, 290; Cambridge Springs, 1520; Venango, 260; Saegerstown, 720; Meadville, 12,780; Cochranton, 700; Utica, 270.

The general reconnoissance of the basin showed that topographical conditions are favorable for a reservoir on the main stream, a short distance above Franklin, and on each of the following tributaries: North Branch, Cussewago and Sugar. Examination of the main stream, some miles below the mouth of North Branch, showed the valley to be too broad and flat for economic reservoiring, as the farm land here is valuable and in addition several villages would be affected. The East Branch and Muddy Creek were found to have similar topographic conditions, the former having two important railroads on the flats. A site of smaller capacity than the North Branch project might be located on Woodcock Creek.

On account of railroad interference, the site on the main stream was not decided upon until after an inspection trip made in this territory by the Engineering Committee, near the close of actual field work. The approximate location selected for the dam was above the mouth of Sugar Creek and the survey extended from here upstreamward. Later, after certain studies had been made in the office, the dam was moved down below the mouth of that creek and the location in this case was made from the United States Geological Survey map, which covers the lower part of the valley. With this site the impounded water would back into the Sugar Creek valley and the project upon that stream will of course be abandoned if the reservoir on the main stream is constructed.

Reservoir Project. (14).

The site for the dam, as proposed, would be 3.4 miles from the Allegheny River, where rock exposures along the stream indicate that rock footing is within reach along the full length of the dam. The principal damage caused by this project would be the removal, to above flow line, of the greater part of the village of Utica, and something over 19 miles of single track of the Franklin Branch of the Erie Railroad, which follows close to the left bank. Topographic conditions on higher ground along the valley are suitable for the accommodation of these and of the other developments, which are small.

The city of Franklin, of about 10,000 population, is three miles below the proposed

site, while the town of Cochranton, with about 700 population, would be immediately at the head of backwater. The lower stretches of French Creek, immediately along the banks between settlements, are not so well developed as much of the country in the upper portions. From a point on the right bank, a short distance below Cochranton, the side hill belt down to stream edge is almost entirely devoid of habitation practically all the way to Utica, and much of it is covered with brush, though the upland is under good cultivation. At some places, particularly a short distance below Utica, the valley is narrow. The maximum capacity available at this site is required for flood control.

Important Features.

Drainage area above dam	1,226 sq. mi.
Capacity of reservoir	3,323,100,000 cu. ft.
Height dam above stream	75 feet
Length of crest	1,550 "
Elevation of crest	1,060 "
Length of reservoir	19.3 miles
Average width	1,387 feet
Average depth	23.5 "
Area of surface	3235 acres

Property Involved.

Land below flow line, 2,527 acres; marginal strip, 272 acres; total, 2,799 acres (23% wooded).

Utica: dwellings, 49; barns, 23; schools, 1; churches, 1; stores, 5; hotels, 1; grist mills, 1; livery stables, 2; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 26; barns, 12; schools, 1; churches, 1; railroad store houses, 1; Venango County Poor House; sand elevators, 1; oil wells, 11; ordinary highway, 7 miles; brick paved highway, 0.8 mile; railroad, 19.5 miles of main line; railroad bridges, 1; highway bridges, 2.

Estimate of Cost.

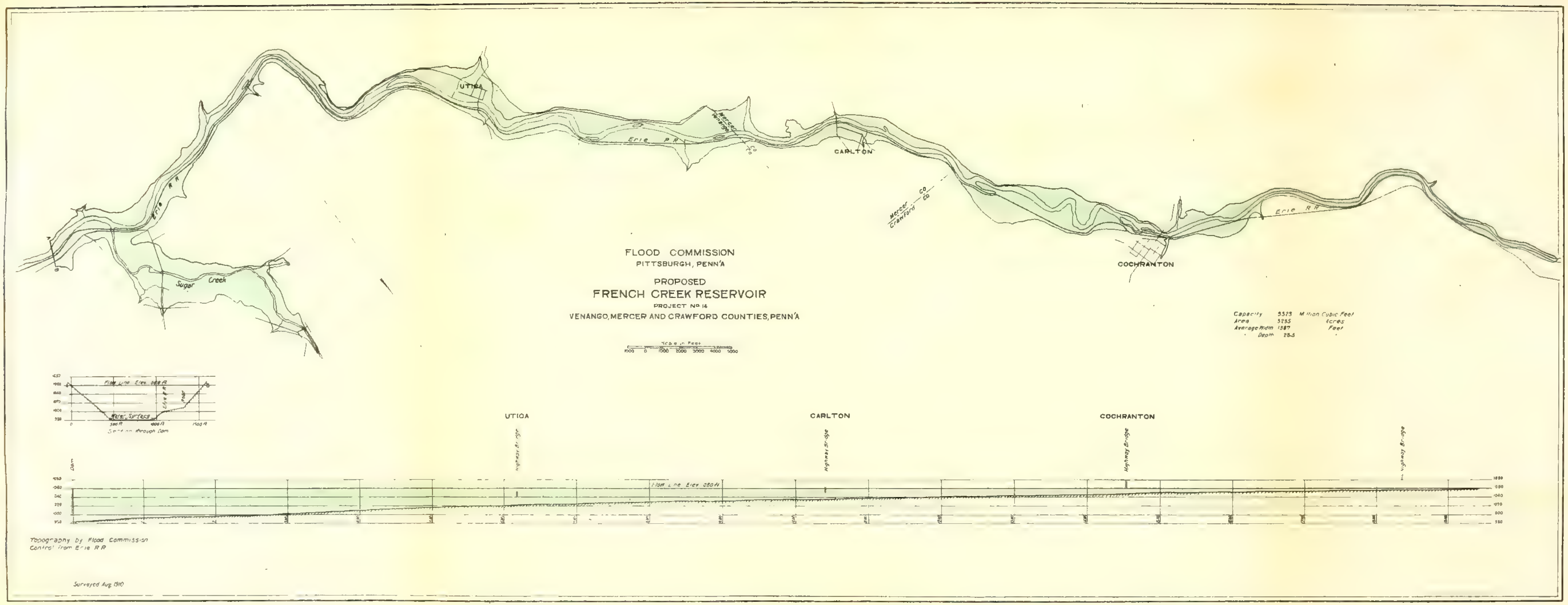
Dam		
Excavation	$ 26,500	
Concrete	676,500	
Riprap paving	1,200	
Gate house and appurtenances	48,500	
		$ 752,700
Land		166,200
Buildings		223,600
Highways		13,400
Railroads		585,000
Bridges		335,700
Total		$2,076,600
Total, plus 15% for engineering and contingencies		2,388,100
Cost per million cubic feet of storage		719

SUGAR CREEK.

Sugar Creek has its main source in the southeastern part of Crawford County and flows almost due south a distance of 21 miles, joining French Creek on the left bank, 4 miles above the junction of that stream with the Allegheny River. From Cooperstown, which is 6.5 miles above the mouth, the stream falls at the rate of 19.0 feet per mile, to an elevation of 997 feet. The drainage basin, which is fan-shaped, has an area of 163 square miles and lies, for the greater part, in the northwestern portion of Venango County. Practically the western half of the basin is situated within the gla-

Clarion River, Pa., October, 1910.
View up stream, showing crest of proposed Dam No. 2.

French Creek, Pa., December, 1910.
View up stream, showing crest of proposed dam.


FLOOD COMMISSION
PITTSBURGH, PENN'A
PROPOSED
FRENCH CREEK RESERVOIR
PROJECT No. 14
VENANGO, MERCER AND CRAWFORD COUNTIES, PENN'A
Scale in Feet
1000 0 1000 2000 3000 4000 5000
UTICA
CARLTON
COCHRANTON
Erie R.R.
Sugar Creek
Mercer Co.
Venango Co.
Crawford Co.
Capacity 3323 Million Cubic Feet
Area 3295 Acres
Average Width 1387 Feet
Depth 28.5
Flow Line Elev.
Water Surface
Section through Dam
Dam
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Topography by Flood Commission
Control from Erie R.R.
Surveyed Aug 1910

ciated region, and in this section are several small lakes of glacial origin. About 25 per cent of the drainage area is under forest cover. A considerable part of the valley is cultivated and the hillsides have moderate slopes. A short distance above the mouth there are a number of oil wells, which have decreased to a small production.

Reservoir Project. (14-A).

The topography of the valley is not favorable for a reservoir project, in comparison with the formation of some of the other selected sites. Inspection indicated, however, that a dam could be placed about 0.2 of a mile above the mouth of the stream, above which point the valley widens considerably. Immediately at the stream, on line of the proposed dam, the rock surface is estimated to be at a depth of about 12 feet. Due to the peculiar formation of the valley and a projecting hill of gravel, which is situated on the west side of the stream, it is estimated, in case this dam is built, that it will be of earth, with a concrete spillway and a core wall going down to rock. It is proposed that this site will only be used in case the French Creek project is abandoned, which might be the case if further investigations should show an undue amount of interference with railroad and other developments obtaining along that valley. As is mentioned in the description of the French Creek project, the idea of having the Sugar Creek reservoir was abandoned, as it would be involved by the backwater from the French Creek project.

Important Features.

Drainage area above dam	163	sq. mi.
Capacity of reservoir	894,000,000	cu. ft.
Height dam above stream	67	feet
Length of crest	3,150	"
Elevation of crest	1,070	"
Length of reservoir	3.4	miles
Average width	1,714	feet
Average depth	29.0	"
Area of surface	708	acres

Property Involved.

Land below flow line, 676 acres; marginal strip, 41 acres; total, 717 acres (15% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 9; barns, 9; churches, 1; oil wells, 15; highway bridges, 1; high-grade highway, 2.1 miles.

Estimate of Cost.

Dam		
Excavation	$ 29,400	
Embankment	121,000	
Concrete	418,800	
Riprap paving	5,800	
Paving earth dam	32,300	
Broken stone lining	8,100	
Gate house and appurtenances	24,700	
		$ 640,100
Land		37,400
Buildings		17,600
Highways		11,100
Bridges		19,600
Total		$ 725,800
Total, plus 15% for engineering and contingencies		834,700
Cost per million cubic feet of storage		934

CUSSEWAGO CREEK.

This stream rises in the southwestern part of Erie County, and flows southwardly 36 miles, joining French Creek at the city of Meadville, 28 miles from the Allegheny. The source, on the Allegheny-Erie divide, is 1250 feet above sea, and the average fall to the mouth, where the elevation is 1068 feet, is 5 feet per mile. The drainage basin has an area of 105 square miles, enclosed by a watershed whose greatest length is 20 miles and average width 5.2 miles. The surrounding hills have moderate slopes and are for the most part cultivated. About 16 per cent of the basin is under forest cover.

The discharge at the mouth varies between a maximum of 5000 second-feet, or 47.6 second-feet per square mile, and a minimum of 3 second-feet, or 0.029 second-foot per square mile. There is a difference of about 16 feet between high and low water.

Reservoir Project. (15).

The lower reaches of this valley are noticeably glacial, being filled up to considerable depth with drift, with the surface of the bottom land generally well leveled over and swampy. In this part of the valley, the hills slope to the edge of the bottom land or flood plain with unusual regularity on each side for 10 miles above the mouth, there being practically no tributaries of any size. The general axis of the valley is rather straight, but the stream is exceptionally crooked and sluggish, flowing between very low banks, in a multitude of small bends, a distance of 17 miles in the reservoir length of 7.4 miles. On this account the profile of this project has been plotted on the line of the reservoir instead of following the meanderings of the stream as has been done with all other projects. The fall in this section is but 1.1 feet to the mile. A considerable part of the valley, including the bottom land, is fairly well farmed, and much of it is used for grazing. The annual small rises of the water inundate nearly half the area considered for the reservoir.

The site selected for the dam is 2.1 miles above the stream mouth. This is the only dam of the 43 which would not have rock footings, according to our investigations of the sites. A dug well near the right bank indicates solid rock at reasonable depth; but from here to the end of the dam, on the left bank, it is considered that it cannot be reached, as wells driven in the locality, for municipal water supply, show rock to be nearly 100 feet below ground surface. An earthen dam is proposed, with a concrete core wall the entire length and height, founded on piles driven well into the drift formation. From end to end, along the upper edge of the wall, steel sheet piling would be driven to impervious material. The waste weir would be built on the rock end of the dam. The maximum capacity available at this site for flow line elevation 1100 feet is 1,817,400,000 cubic feet. The studies, however, showed that this capacity is greater than needed for flood control purposes, and the flow line elevation was therefore lowered to 1092 feet, reducing the capacity to 767,800,000 cubic feet.

Important Features.

Drainage area above dam	103 sq. mi.
Capacity of reservoir	767,800,000 cu. ft.
Height dam above stream	19 feet
Length of crest	2,840 "
Elevation of crest	1,092 "
Length of reservoir	7.4 miles
Average width	2,279 feet
Average depth	8.0 "
Area of surface	2,249 acres


1100
1080
1060
1100
1080
1060
Cont

CUSSEWAGO CREEK.

This stream rises in the southwestern part of Erie County, and flows southwardly 36 miles, joining French Creek at the city of Meadville, 28 miles from the Allegheny. The source, on the Allegheny-Erie divide, is 1250 feet above sea, and the average fall to the mouth, where the elevation is 1068 feet, is 5 feet per mile. The drainage basin has an area of 105 square miles, enclosed by a watershed whose greatest length is 20 miles and average width 5.2 miles. The surrounding hills have moderate slopes and are for the most part cultivated. About 16 per cent of the basin is under forest cover.

The discharge at the mouth varies between a maximum of 5000 second-feet, or 47.6 second-feet per square mile, and a minimum of 3 second-feet, or 0.029 second-foot per square mile. There is a difference of about 16 feet between high and low water.

RESERVOIR PROJECT. (15).

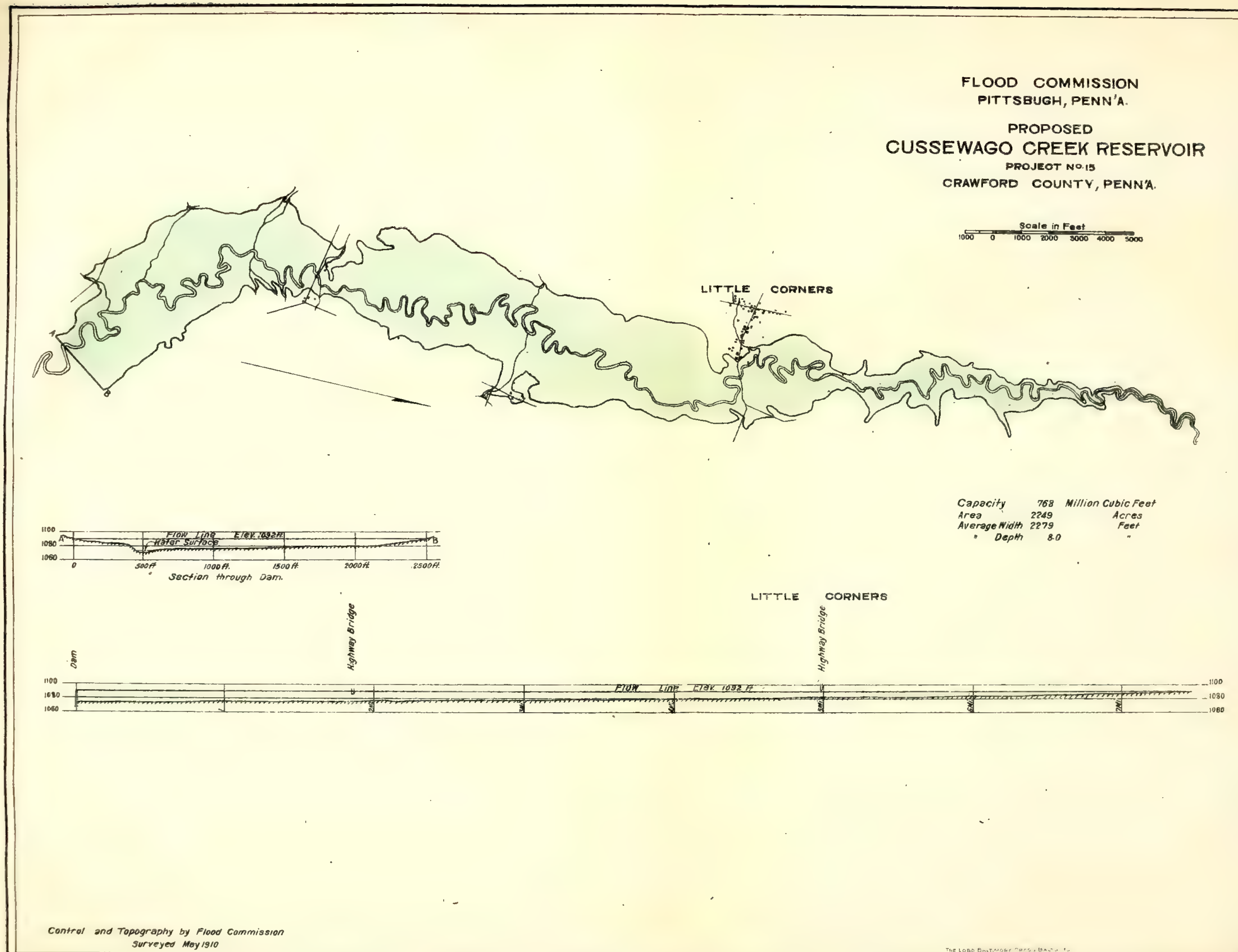
The lower reaches of this valley are noticeably glacial, being filled up to considerable depth with drift, with the surface of the bottom land generally well leveled over and swampy. In this part of the valley, the hills slope to the edge of the bottom land or flood plain with unusual regularity on each side for 10 miles above the mouth, there being practically no tributaries of any size. The general axis of the valley is rather straight, but the stream is exceptionally crooked and sluggish, flowing between very low banks, in a multitude of small bends, a distance of 17 miles in the reservoir length of 7.4 miles. On this account the profile of this project has been plotted on the line of the reservoir instead of following the meanderings of the stream as has been done with all other projects. The fall in this section is but 1.1 feet to the mile. A considerable part of the valley, including the bottom land, is fairly well farmed, and much of it is used for grazing. The annual small rises of the water inundate nearly half the area considered for the reservoir.

The site selected for the dam is 2.1 miles above the stream mouth. This is the only dam of the 43 which would not have rock footings, according to our investigations of the sites. A dug well near the right bank indicates solid rock at reasonable depth; but from here to the end of the dam, on the left bank, it is considered that it cannot be reached, as wells driven in the locality, for municipal water supply, show rock to be nearly 100 feet below ground surface. An earthen dam is proposed, with a concrete core wall the entire length and height, founded on piles driven well into the drift formation. From end to end, along the upper edge of the wall, steel sheet piling would be driven to impervious material. The waste weir would be built on the rock end of the dam. The maximum capacity available at this site for flow line elevation 1100 feet is 1,817,400,000 cubic feet. The studies, however, showed that this capacity is greater than needed for flood control purposes, and the flow line elevation was therefore lowered to 1092 feet, reducing the capacity to 767,800,000 cubic feet.

Important Features.

Drainage area above dam	103 sq. mi.
Capacity of reservoir	767,800,000 cu. ft.
Height dam above stream	19 feet
Length of crest	2,840 "
Elevation of crest	1,092 "
Length of reservoir	7.4 miles
Average width	2,279 feet
Average depth	8.0 "
Area of surface	2,249 acres

PLATE 31


FLOOD COMMISSION
PITTSBUGH, PENN'A.
PROPOSED
CUSSEWAGO CREEK RESERVOIR
PROJECT No. 15
CRAWFORD COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
LITTLE CORNERS
A
B
Capacity 768 Million Cubic Feet
Area 2249 Acres
Average Width 2279 Feet
" Depth 8.0 "
1100
1080
1060
Flow Line Elev. 1092 ft.
Water Surface
0
500 ft.
1000 ft.
1500 ft.
2000 ft.
2500 ft.
Section through Dam.
LITTLE CORNERS
Dam
Highway Bridge
Highway Bridge
Flow Line Elev. 1092 ft.
Control and Topography by Flood Commission
Surveyed May 1910

Property Involved.

Land below flow line, 2,139 acres; marginal strip, 400 acres; total, 2,539 acres (13% wooded, 43% swamp).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 8; barns, 3; ordinary highway, 1.5 miles; highway bridges, 2.

Estimate of Cost.

Dam		
Excavation	$ 38,700	
Embankment	118,100	
Concrete	234,800	
Riprap paving	1,500	
Paving earth dam	30,900	
Broken stone lining	7,700	
Sheet piling	2,700	
Gate house and appurtenances	24,000	
		$ 458,400
Land		49,800
Buildings		10,300
Highways		4,200
Bridges		49,300
Total		$ 572,000
Total, plus 15% for engineering and contingencies		657,800
Cost per million cubic feet of storage		857

NORTH BRANCH OF FRENCH CREEK.

This stream, which has been referred to as the headwaters of French Creek, rises in New York State, and flows southwestwardly a distance of 36 miles to the junction with the East Branch at Le Boeuff, a small settlement on the Philadelphia & Erie Railroad, at the head of the main stream. The fall of the stream per mile is 15.1 feet, much of the steeper part being in the upper portion, above the proposed reservoir. The elevation of the mouth is 1197 feet and the distance from here to the Allegheny is 62 miles. The drainage basin, area 217 square miles, has a full length of 26 miles and an average width of 8.4 miles, about half of it lying in the State of New York. About 23 per cent of the basin is wooded.

The discharge rises to a maximum of 12,000 second-feet, or 56.5 second-feet per square mile, and in dry years drops to about 20 second-feet, or 0.094 second-foot per square mile. There is a difference of about 13 feet between high and low water.

RESERVOIR PROJECT. (16).

This is the most northern of all the proposed sites. The dam would have its location 1.2 miles above the mouth of the stream, and judging from rock exposures in the banks nearby, and in the stream bed, the structure would have rock foundation at slight depth throughout its entire length. Parts of several small settlements would be involved and some farming country of not very high grade, some of it being composed of patches of brush and swamp land. The backwater would also affect the village of Wattsburg, having about 300 inhabitants, located at the head of the proposed reservoir, several miles from the corner of New York State. This town was built up during the early lumber days but now appears to be on the decline. The maximum capacity of this site is used for flood control.

Important Features.

Drainage area above dam	216 sq. mi.
Capacity of reservoir	2,125,700,000 cu. ft.
Height dam above stream	67 feet
Length of crest	1,015 "
Elevation of crest	1,280 "
Length of reservoir	9.5 miles
Average width	1,980 feet
Average depth	21.5 "
Area of surface	2,281 acres

Property Involved.

Land below flow line, 2,141 acres; marginal strip, 167 acres; total, 2,308 acres (17% wooded, 16% swamp).

Kimmeytown: dwellings, 1; barns, 2; highway bridges, 1. Arbuckle: dwellings, 6; barns, 8; schools, 1; highway bridges, 1. Wattsburg: dwellings, 25; barns, 15; stores, 2; grist mills, 1; stables, 2; blacksmith shops, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 18; barns, 18; schools, 2; churches, 1; cheese factories, 1; ordinary highway, 6.1 miles; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 17,000	
Concrete	367,400	
Riprap paving	5,100	
Gate house and appurtenances	32,700	
		$ 422,200
Land		54,700
Buildings		103,700
Highways		15,600
Bridges		32,300
Total		$ 628,500
Total, plus 15% for engineering and contingencies		722,800
Cost per million cubic feet of storage		340

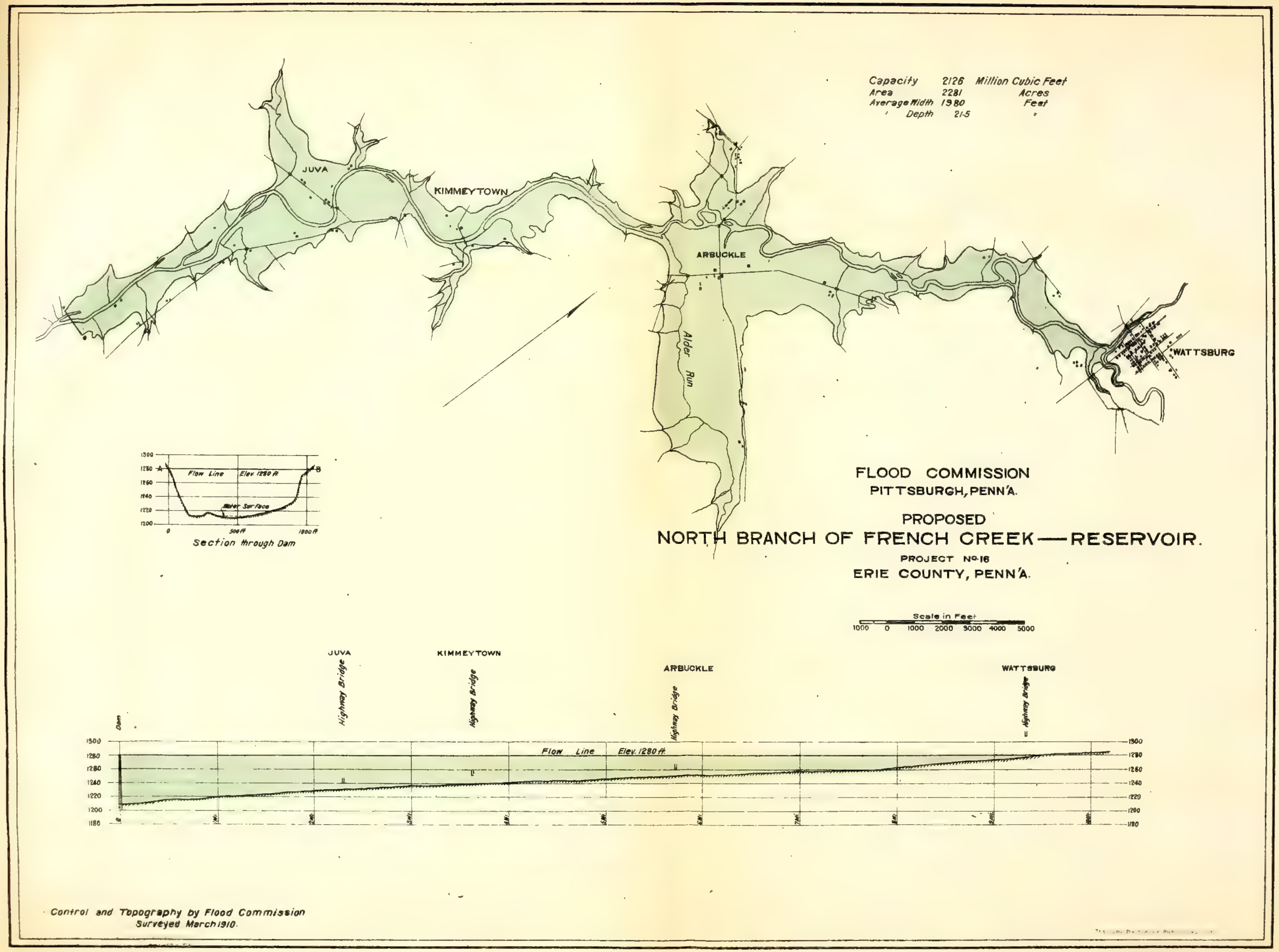
TIONESTA CREEK.

Tionesta Creek, which, from the head of the Allegheny River, is the fourth large stream entering on the east, has its source in the southern part of Warren County, only four miles from the Allegheny. In its course of 57 miles it is quite winding, as from the head it flows 10 miles northeastwardly, paralleling the Allegheny, contrary to the general drainage of the region, thence southeastwardly, thence southwardly and finally southwestwardly, until the Allegheny is joined at the town of Tionesta, on the left bank, 20 miles above Oil City, and 154 miles above Pittsburgh. For the lower 44 miles of its course the stream has a fall of 6.9 feet per mile, dropping to an elevation of 1043 feet at the mouth.

The watershed, with an extreme length of 54 miles, and an average width of about 13 miles, and with summits reaching altitudes of 1500 to 2000 feet above sea, encloses an area of 477 square miles and covers portions of Warren, McKean, Elk, Forest and Clarion counties. At the town of Kane, at the eastern end, and at the junction of Tionesta-Kinzua-Clarion divide, the elevation is 2050 feet above sea. About 86 per cent of the drainage area is under forest cover, which includes 36 square miles of burned over land and several tracts of virgin timber, aggregating 54 square miles, lying along the stream above Kellettville.

Kinzua Creek, Pa., December, 1910.
View down stream, showing crest of proposed dam.

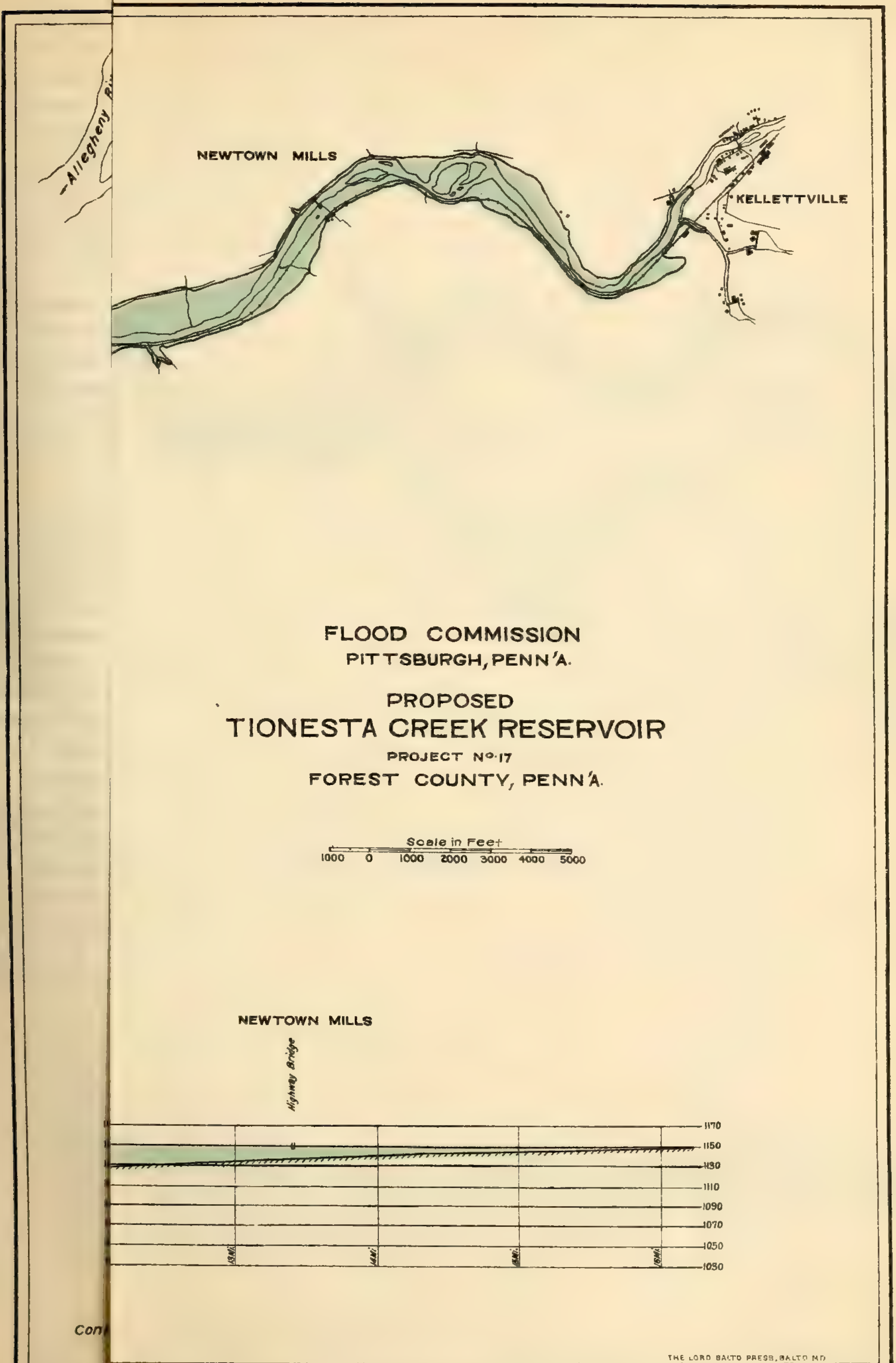
North Branch French Creek, Pa., December, 1910.
View down stream, showing crest of proposed dam.

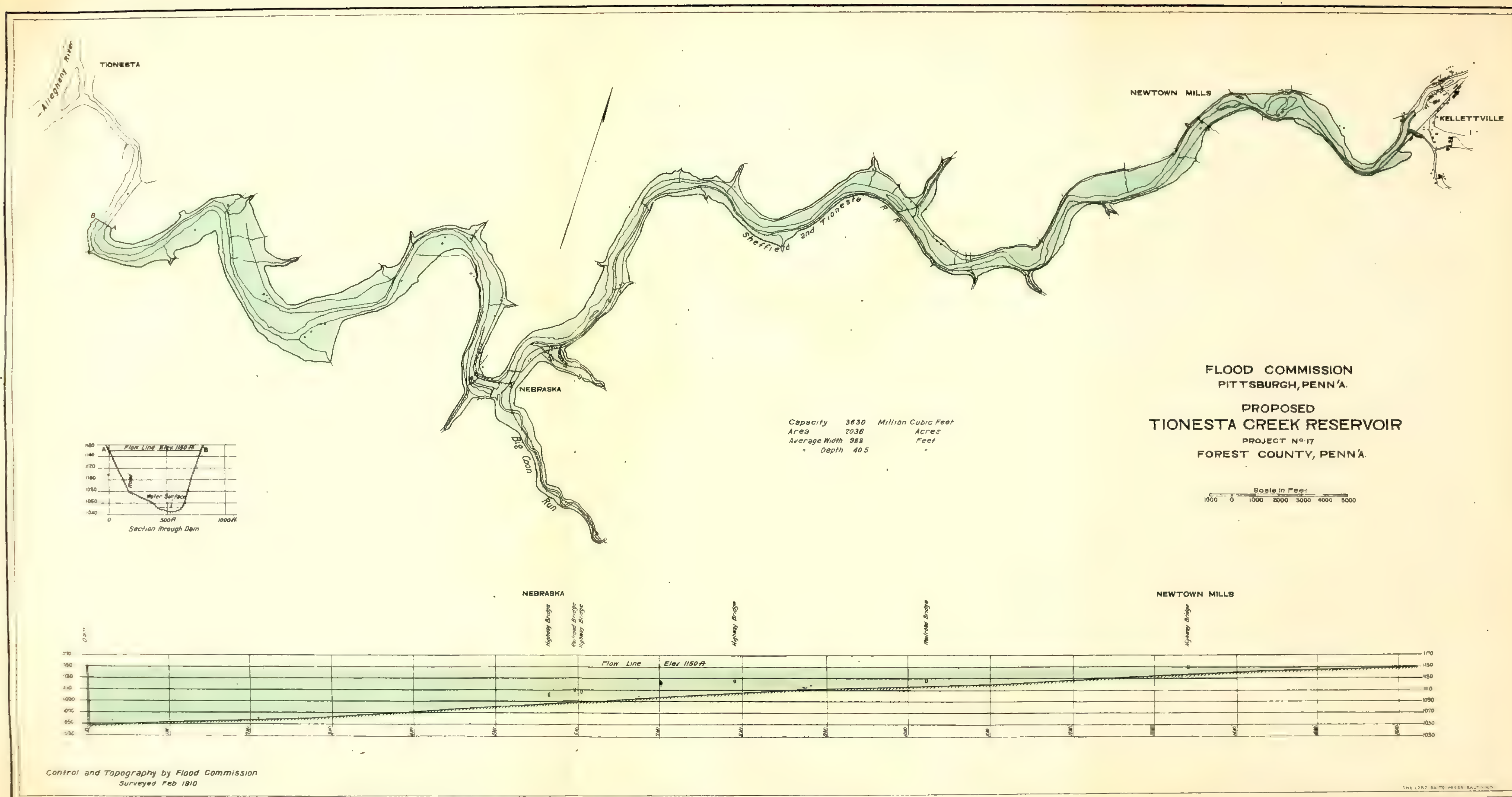


Capacity 2126 Million Cubic Feet
Area 2281 Acres
Average Width 1980 Feet
" Depth 21.5 "
JUVA
KIMMEYTOWN
ARBUCKLE
WATTSBURG
Alder Run
Flow Line Elev. 1280 ft.
Water Surface
Section through Dam
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
NORTH BRANCH OF FRENCH CREEK—RESERVOIR.
PROJECT No. 16
ERIE COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Dam
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Control and Topography by Flood Commission
Surveyed March 1910.

Tionesta Creek, Pa., December, 1910.
View down stream, from a point 2 miles below village of Nebraska.

Tionesta Creek, Pa., December, 1910.
View down stream; village of Nebraska.


NEWTOWN MILLS
KELLETTVILLE
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
TIONESTA CREEK RESERVOIR
PROJECT Nº 17
FOREST COUNTY, PENN'A.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
NEWTOWN MILLS
Highway Bridge
1170
1150
1130
1110
1090
1070
1050
1030
THE LORD BALTO PRESS, BALTO MD


TIONESTA
Allegheny River
NEWTOWN MILLS
KELLETTVILLE
NEBRASKA
Sheffield and Tionesta R.R.
Big Coon Run
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
TIONESTA CREEK RESERVOIR
PROJECT No. 17
FOREST COUNTY, PENN'A.
Capacity 3630 Million Cubic Feet
Area 2036 Acres
Average Width 988 Feet
" Depth 40.5 "
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line Elev 1150 ft
Water Surface
Section through Dam
NEBRASKA
NEWTOWN MILLS
Highway Bridge
Railroad Bridge
Highway Bridge
Highway Bridge
Railroad Bridge
Highway Bridge
Flow Line Elev 1150 ft
Control and Topography by Flood Commission
Surveyed Feb 1910

The discharge at the mouth reaches a maximum of 21,750 second-feet, or 45.6 second-feet per square mile, and in extremely dry years, falls to 40 second-feet, or 0.084 second-foot per square mile. There is a difference of about 18 feet between high and low water.

The topography of the general valley is somewhat similar to that of the Clarion, except that on the lower reaches there is more wide bottom land. From the mouth to Kellettville, a distance of 17 miles, the valley has very attractive scenery. Along this part it is thinly populated, the hamlet of Nebraska being the only place worthy of note; but from Kellettville to Sheffield, small villages range along the stream several miles apart. At Mayburg, a short distance above Kellettville, an oil field of limited area has been opened. Geologically, the stream bed, at least in the lower valley, is in a shale and sandstone formation below the thick Kinzua sandstone, which is prominent here and there on the hillsides.

The principal towns along the valley and their respective populations are as follows: Clarendon, 930; Sheffield, 2500; Mayburg, about 100; Kellettville, 1500; Nebraska, about 200; Tionesta, 800.

Reservoir Project. (17).

The general physical conditions are favorable for a storage reservoir of large capacity with the dam located on rock foundations, 1.2 miles from the Allegheny River. The small lumber village of Nebraska, situated 6.8 miles from Tionesta, would be almost entirely flooded by the project. Fortunately, however, suitable ground exists at slight height above the proposed flow line for the accommodation of the village and other developments of the valley. A small portion of the lower part of Kellettville will also be affected. Some of the broad bottom land, which is mostly on the lower part of the project, is in a fair state of cultivation; but none of it would be classed, in its present state, as good farm land.

The Sheffield & Tionesta Railroad, an independent line built for the lumber business, operates one train with small passenger service each way, daily, between Nebraska and Sheffield, 32 miles distant, connecting there with the Philadelphia & Erie Railroad. It was stated by good authority that in about eight years' time the lumber business will probably cease to be an important factor in the valley. The saw mill at Nebraska has a daily capacity of 35,000 feet board measure, and the box factory turns out about two carloads of manufactured box lumber per day. The estimates provide for removal of the railroad property to above flow line of reservoir.

Important Features.

Drainage area above dam	477	sq. mi.
Capacity of reservoir	3,629,600,000	cu. ft.
Height dam above stream	103	feet
Length of crest	800	"
Elevation of crest	1,150	"
Length of reservoir	16.2	miles
Average width	988	feet
Average depth	40.5	"
Area of surface	2,036	acres

Property Involved.

Land below flow line, 1,561 acres; marginal strip, 224 acres; total, 1,785 acres (61% wooded).

Nebraska: dwellings, 38; barns, 10; schools, 1; churches, 1; stores, 1; saw mills, 3; grist mills, 1; highway bridges, 1; railroad bridges, 1; round houses, 1; machine shops, 1. In other parts of the

valley are the following, which have been included in the estimate: dwellings, 20; barns, 15; schools, 2; saw mills, 1; highway bridges, 4; boiler houses, 6; ordinary highway, 3.3 miles; railroads, such as described, 10 miles of main line and 3 miles of branch line.

Estimate of Cost.

Dam		
Excavation	$ 11,700	
Concrete	447,600	
Riprap paving	2,700	
Gate house and appurtenances	47,700	
		$ 509,700
Land		29,000
Buildings		101,500
Highways		17,500
Railroads		204,000
Bridges		323,200
Total		$1,184,900
Total, plus 15% for engineering and contingencies		1,362,600
Cost per million cubic feet of storage		376

KINZUA CREEK.

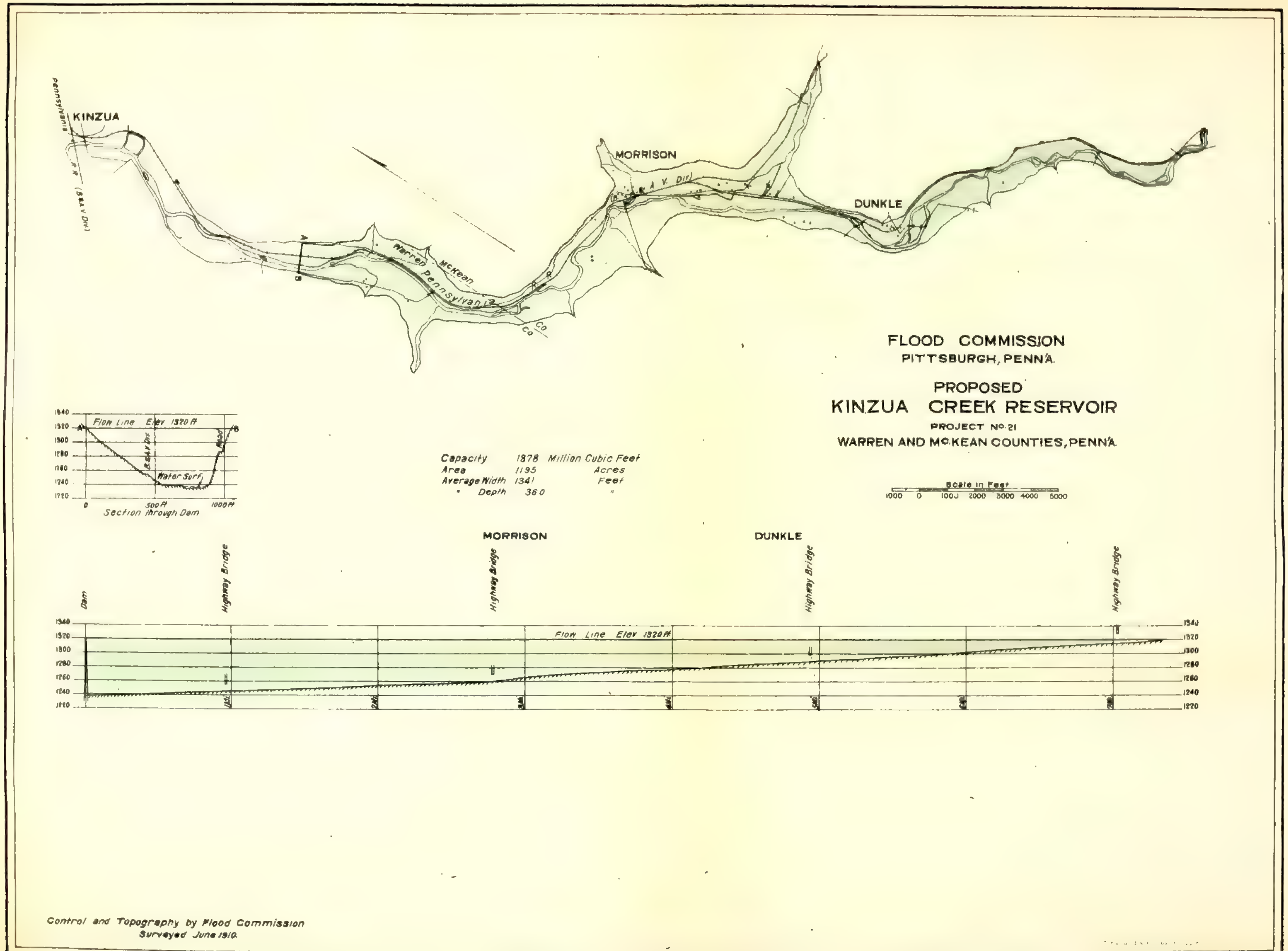
Kinzua Creek rises in the central part of McKean County, flows northwestwardly for a distance of 32 miles and enters the Allegheny River in the extreme eastern part of Warren County, at the village of Kinzua, on the left bank, 10 miles above the city of Warren, and 202 miles above Pittsburgh. The elevation of the stream at the Kinzua viaduct of the Erie Railroad, 27 miles above the mouth, is about 1790 feet above tide, and the fall is 21.5 feet per mile from this point to the mouth, where the elevation is 1211 feet.

The drainage basin has an area of 169 square miles, practically all of which lies in McKean County, with its northern edge about nine miles south of the New York state line. It is just within the southern border of the high plateau that surrounds the headwaters of the Allegheny, and the topography over much of the region is rough, with deep and comparatively narrow ravines, the surrounding hills reaching from 2000 to 2200 feet above sea. As hard rock formation is evident in most of this region, and about 90 per cent of the basin is covered with underbrush and timber of varying size, it is thought that erosion does not occur to any considerable extent. At a number of places massive sandstone ledges are noticeable high on the hills and this formation overlies the shale which is along the bed of the valley.

The discharge from the drainage area of 162 square miles at Dewdrop, 3.7 miles above the mouth, since the establishment of a gaging station in October, 1909, has varied between a maximum of 3200 second-feet, or 20 second-feet per square mile, and 20 second-feet, or 0.123 second-foot per square mile. The maximum occurred in 1907, when there was a discharge of 7660 second-feet, or 47.3 second-feet per square mile; while in an extremely dry year, the flow is estimated to drop to about 13 second-feet, or 0.08 second-foot per square mile. There is a difference of about 10 feet between high and low water.

Beginning at the headwaters of the Allegheny, this stream is the third large tributary, and the first that has favorable topography for a reservoir of any considerable size, on the lower reach of the stream.

Tionesta Creek, Pa., December, 1910.
View up stream, showing crest of proposed dam.


KINZUA
Pennsylvania
R. R.
(B. & A. V. Div.)
MORRISON
A. V. Div.
DUNKLE
Warren
McKean
Pennsylvania
Co
Co
A
B
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
KINZUA CREEK RESERVOIR
PROJECT No. 21
WARREN AND McKEAN COUNTIES, PENN'A.
Capacity 1878 Million Cubic Feet
Area 1195 Acres
Average Width 1341 Feet
" Depth 36.0 "
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line Elev 1320 ft
B. & A. V. Div.
Water Surf.
Road
0 500 ft 1000 ft
Section through Dam
MORRISON
DUNKLE
Dam
Highway Bridge
Highway Bridge
Highway Bridge
Highway Bridge
Flow Line Elev 1320 ft
1340
1320
1300
1280
1260
1240
1220
Control and Topography by Flood Commission
Surveyed June 1910.

Reservoir Project. (21).

The examination of the valley determined that it was possible to locate a reservoir in the lower reach, with the dam 2.7 miles from the mouth. It would involve, however, the relocation of a branch railroad and ordinary highways, the removal of a chemical plant, which has just been built to use up a considerable amount of small timber growth remaining on the hillsides, and the relocation of two small settlements, namely, Morrison and Dunkle. Suitable ground obtains above flow line for the accommodation of all these developments. Nearly a mile above the proposed dam site, on low ground close to the left bank of the creek, the town of Dewdrop was located. This place was of some importance during lumber activities, but little now remains to show that it ever existed. The railroad, during the lumber industry, did a large business, but now operates only several trains a week through the sparsely settled valley. There are no indications that any great change will take place throughout its entire length, at least for many years to come. Some of the cleared bottom land for ten miles above the mouth is in a poor state of cultivation and a little of it is in pasture.

At the site of the dam, judging from surrounding geological conditions, it is considered that rock footings can be obtained a few feet under the bed of the stream.

Important Features.

Drainage area above dam	163 sq. mi.
Capacity of reservoir	1,877,800,000 cu. ft.
Height dam above stream	83 feet
Length of crest	1,050 "
Elevation of crest	1,320 "
Length of reservoir	7.3 miles
Average width	1,341 feet
Average depth	36 "
Area of surface	1,195 acres

Property Involved.

Land below flow line, 1,093 acres; marginal strip, 104 acres; total, 1,197 acres (56% wooded).

Morrison: dwellings, 23; chemical works, 1; barns, 10; cemeteries, 1; schools, 1; highway bridges, 1; power houses, 1; oil wells, 3; saw mills, 1. At Dunkle and in other parts of the valley are the following, which have been included in the estimate: dwellings, 8; barns, 7; churches, 1; stores, 1; boiler houses, 1; oil wells, 4; ordinary highway, 6.6 miles; railroad, such as described, 7.6 miles; highway bridges, 4. Oil evidently does not exist in large quantity, as the wells above mentioned are of very small production and the field is not large.

Estimate of Cost.

Dam		
Excavation	$ 23,700	
Concrete	453,300	
Riprap paving	3,100	
Gate house and appurtenances	25,500	
		$ 505,600
Land		18,300
Buildings		144,700
Highways		47,700
Railroads		168,000
Bridges		5,000
Total		$ 889,300
Total, plus 15% for engineering and contingencies		1,022,700
Cost per million cubic feet of storage		544

TABLE No. 31.

IMPORTANT FEATURES OF RESERVOIR PROJECTS. ALLEGHENY BASIN.

Name	Number	Distance from dam to mouth	Drainage area above dam	Dam: Height above stream surface	Dam: Length of crest	Dam: Elevation of crest, Govt. datum	Reservoir: Length	Reservoir: Average width	Reservoir: Average depth	Reservoir: Area of surface	Reservoir: Capacity	Reservoir: Time required to empty	Reservoir: 6'x9' gates	Land area submerged: Total	Land area submerged: Wooded
		Miles	Sq. miles	Feet	Feet	Feet	Miles	Feet	Feet	Acres	Mill. cu. ft.	Days	No.	Acres	Per cent
Buffalo	1	11.7	98	100	....	980	6.3	848	31.0	647	882.8	2.4	2	616	30
Loyalhanna	2	1.3	277	122	1370	960	19.1	1198	34.0	2778	4112.5	3.5	6	2621	36
Black Lick	3	0.3	414	63	1330	960	10.6	1037	25.0	1333	1454.7	1.0	10	1098	45
Crooked	4	0.2	287	94	1100	855	14.5	1085	39.0	1906	3255.7	2.7	7	1706	19
Mahoning No. 1	5	13.6	385	108	925	1020	7.3	778	47.5	689	1421.7	1.0	8	451	71
Mahoning No. 2	6	20.9	335	143	740	1150	14.3	645	35.0	1554	2367.8	1.3	8	1244	50
Little Sandy	7	0.1	78	111	590	1200	7.4	965	27.0	861	1007.5	2.5	2	786	24
N. Br. Red Bank	8	1.5	101	83	...	1300	5.0	1233	41.5	747	1350.0	3.1	3	710	95
Clarion No. 1	9	0.3	1212	142	880	1000	23.6	708	57.5	2024	5067.0	1.1	12	1160	85
Clarion No. 3	10	35.9	874	128	800	1200	22.7	928	44.0	2555	4886.6	1.3	10	1843	77
Clarion No. 4	11	58.6	724	70	880	1260	14.1	711	29.0	1219	1537.9	0.5	5	825	73
East Sandy No. 1	12	0.6	103	55	755	1010	1.7	553	28.0	113	137.7	0.3	3	93	57
East Sandy No. 2	13	2.3	96	57	620	1050	1.9	405	25.5	91	102.1	0.2	3	78	73
French	14	3.4	1226	75	1550	1060	19.3	1387	23.5	3235	3323.1	2.0	10	2527	23
Sugar	14A	0.2	163	67	a3150	b1070	3.4	1714	29.0	708	894.0	1.3	5	676	15
Cussewago	15	2.1	103	19	a2840	b1092	7.4	2279	8.0	2249	767.8	2.5	5	2139	13
N. Br. French	16	1.2	216	67	1015	1280	9.5	1980	21.5	2281	2125.7	2.5	6	2141	17
Tionesta	17	1.2	477	103	800	1150	16.2	988	40.5	2036	3629.6	1.9	11	1561	61
Allegheny No. 1	18	138.6	4272	63	810	1056	16.3	1206	27.5	2379	2876.3	1.9	10	1066	55
Allegheny No. 2	19	154.9	3652	66	1670	1113	15.9	1701	34.5	3257	4877.9	3.3	10	1737	27
Allegheny No. 3	20	170.8	3488	54	1415	1158	14.7	1384	25.0	2461	2663.6	2.1	10	1331	36
Kinzua	21	2.7	163	83	1050	1320	7.3	1341	36.0	1195	1877.8	2.4	5	1093	56
Total		.....	c8454	...	....	....	...	....	....	35610	49725.8	...	..	26826	..
Average		.....	.....	86	1113	....	12.6	1112	32.5	1696	2367.9	...	..	1278	..

Notes: a. This is total length of crest. Length of spillway Cussewago is 550 feet, and Sugar 890 feet.
b. This is crest of spillway. Crest of dam Cussewago is at elevation 1102, and Sugar 1076.
c. Area controlled. Sugar is not included in totals and averages.

MONONGAHELA BASIN.

YOUGHIOGHENY RIVER.

The Youghiogheny, as a branch of the Monongahela River, is the most important commercially, the largest in area of watershed and the second in length of stream, the Cheat River being the longest. It rises in West Virginia, on Backbone Mountain, near the southwestern corner of Maryland, at an elevation of 2900 feet, flows in a northerly course through Maryland and passes into Pennsylvania in the same general course, reaching the town of Confluence 12.5 miles north of the state line. From Confluence, the course is northwesterly to the Monongahela, which it joins 15.6 miles above Pittsburgh, at the city of McKeesport, on the right bank, at an elevation of 715 feet, which is the elevation of slackwater pool No. 2.

In the total length of the stream, 123 miles, the average fall per mile is 17.7 feet. The length of certain reaches and rate of fall per mile are as follows: Beginning at a point 17 miles above the Baltimore & Ohio Railroad bridge, just west of Oakland, elevation 2500 feet; thence to Round Glade Run, 23 miles, 6.8 feet; to Friendsville, 16 miles, 54.9 feet; to Confluence, 18 miles, 8.4 feet; to head of falls at Ohio Pyle, 10 miles, 10.6 feet; to foot of falls, 2 miles, 47.5 feet; to Connellsville, 14 miles, 17.7 feet; to West Newton, 25 miles, 5.0 feet; to the Monongahela (pool No. 2), 19 miles, 1.3 feet.

The watershed, with a length of 87 miles and average width of 20 miles, encloses an area of 1732 square miles, which drains portions of the following counties: Preston, West Virginia; Garrett, Maryland; Fayette, Somerset, Westmoreland and Allegheny, Pennsylvania. This stream, like the Cheat, has no tributary worthy of mention entering on the left, the divide on this side from source to mouth being quite close to the stream for most of its length, ranging from two to five miles, and at one point being nine miles distant; while on the right or east it ranges from ten to eighteen miles and at several places is nearly thirty miles distant. On the east the principal tributaries are as follows: Casselman and Laurel Hill, both joining at Confluence; then in order, downstream, Indian Creek, Jacobs Creek and Big Sewickley Creek.*

Topographically, geologically, and also historically, the Youghiogheny is one of the most interesting streams under discussion. The country of the greater part of the basin is rough and many of the small tributaries, particularly in the upper region, flow through deep, narrow and thinly-settled ravines,the slopes of which are generally wooded. Backbone Mountain, which has a northeasterly and southwesterly trend, forms the watershed above the head of the main stream, with a maximum elevation of about 3400 feet, south of Oakland. This range, in Pennsylvania, has the name of Savage Mountain and in that state is about six miles to the southwest of the Allegheny Mountain.

In the upper half of the basin five well-defined mountain ranges cross with prominent effect, in a northeasterly and southwesterly direction, through the generally broken surface of the region, the altitude of the crests ranging from about 2300 to 3100 feet. A notable feature is that the Allegheny Mountain, extending from the interior of Pennsylvania, does not form the entire southeastern rim of the basin, but passes through a small projecting end at the state line northwest of Cumberland, Maryland. This is caused by a tributary of the Casselman breaking through the mountain in its meanderings from the source, which is on the Savage range, and in this way pushing back the watershed at this one point to that range. The range next to the northwest is Negro Mountain, which has its existence to any marked degree only within the Youghiogheny Basin. This range crosses from a point about two miles east of Rockwood, on the Casselman River, and converges with the Allegheny range northeast of Oakland, on the approach

*Also called Sewickley Creek.

to which junction point, in Maryland, it is called Meadow Mountain. Meadow Mountain reaches a height of about 3050 feet, near the state line. Laurel ridge, with altitudes of 2300 feet, is next to the northwest, and is cut by the main stream about four miles below Confluence. Chestnut ridge, with elevations nearly the same as Laurel, crosses three miles above Connellsville. At both these ridges the stream valley is deep-set and gorge-like, the water at the latter having an elevation of 940 feet. The greater part of the forest cover, which aggregates about 49 per cent of the drainage area, is found upon the crests and slopes of Chestnut, Laurel and Negro mountain ranges. From the foot of Chestnut ridge to the mouth, the basin is practically denuded.

Above Confluence, the main stream flows parallel to the ridge structure, but below that place it breaks through nearly at right angles. From below the railroad bridge, near Oakland, to several miles above Friendsville, the valley proper is narrow, rugged and almost uninhabited, the stream falling over rock ledges and immense rock boulders that have dropped from the slopes. From Friendsville to a point several miles beyond Confluence, the valley widens considerably, and the stream, for the greater part of the distance, flows in level flood plains, which are in pasture or cultivation and alternate from side to side. Bottom land obtains at numerous places, from Dunbar Creek, above Connellsville, to the Monongahela, and upon these areas are located thriving coal mining and manufacturing towns. Connellsville is the heart of the famous coke producing region.

The maximum discharge above its confluence with the Casselman River is estimated at 24,000 second-feet, or 55.5 second-feet per square mile. The minimum recorded discharge is 23 second-feet or 0.053 second-foot per square mile, which occurred in 1908. The difference between high and low water is about 16 feet. At West Newton, where the fluctuation between high and low-water stage is 28 feet, the maximum discharge is estimated at 62,000 second-feet, or 40 second-feet per square mile, and the minimum at 12 second-feet, or 0.0077 second-foot per square mile.

The following railroads are located in this valley: From McKeesport, on the Monongahela, at the mouth of the stream, the main line of the Pittsburgh Division of the Baltimore & Ohio Railroad follows along the right bank to Confluence, from which place it passes up the Casselman toward Cumberland. A branch of this road with light traffic extends to Friendsville. On the left bank is the Pittsburgh & Lake Erie Railroad from the mouth to Connellsville, where an extension is now being made by the Western Maryland Railroad via Confluence and the Casselman River.

The principal towns and their respective populations are as follows: Oakland, Md., 1370; Friendsville, 470; Somerfield, Pa., 180; Confluence, 890; Ohio Pyle, 540; Connellsville, 12,850; Dawson, 850; Smithton, 780; West Newton, 2,880; Suterville, 920; Versailles, 1,440; McKeesport, 42,690.

The Pittsburgh Coal bed of the Monongahela River formation obtains and is mined extensively along the 27 miles from the mouth to Jacobs Creek, from Dawson to Connellsville, and on the tributaries below Jacobs Creek. From Confluence to beyond Oakland, coal beds of the Allegheny formation, apparently of changeable character, underlie the Monongahela measures. The horizons of the beds vary from a considerable distance below to high above the stream bed.

In 1848, the Youghiogheny was made navigable from the mouth to West Newton, for boats of 4-foot draft, by two locks and dams, each of about 14 feet lift. The dams were destroyed by a flood in about the year 1865, however, and no attempt has since been made to restore the slackwater navigation. Under present conditions, the river is navigable up to Boston, a distance of about five miles. Studies are now under way by

Youghiogheny River, Pa., December, 1910.
View up stream, showing crest of proposed Dam No. 1.

Youghiogheny River, Md., December, 1910.
View up stream, showing crest of proposed Dam No. 5.

the United States Engineers to determine the advisability of constructing locks and dams to give a navigable depth of 8 feet up to West Newton.

As the Youghiogheny is a particularly troublesome flood-producing tributary, a careful examination was made to obtain reservoir storage on its lower reaches and on the branches thereof. The topography was found to be favorable for large storage capacity, but the coal formation and developments, together with the towns and settlements, generally on low land, and railroads on grades comparatively close to stream surface, discouraged any attempt to obtain sites of considerable capacity on the main stream or its affluents below the town of Confluence.

Of the sites selected, two are between Confluence and Friendsville and three above the latter place, the upper one backing water along the Little Youghiogheny to Oakland. By careful adjustment of flow line it was found possible, in the aggregate, to obtain considerable storage without overflowing important settlements. The Baltimore & Ohio Railroad branch, however, is involved for much of the distance to Friendsville.

These projects were not entirely surveyed, in detail, by the Flood Commission, but a survey was made at the site of each dam. Along the stream, in project No. 1, cross-sections were taken of the valley and the control for the map based on county surveys. The United States Geological Survey maps, supplemented by field observation, formed the basis of computations for the other projects. Careful levels, based on government bench marks, were run along the stream from Confluence to Oakland.

Reservoir No. 1. (28).

This site, as now proposed, would have the location of its dam 1.1 miles above Confluence, 71.1 miles from the mouth, at the Monongahela River, and 87 miles from Pittsburgh. Geological conditions appear favorable for rock footings at slight depth below ground surface for the entire length of dam, and estimates have been made for reaching it at a depth of 12 feet. A study of the coal structure was made from the best available data, and it would seem that for a distance of about one and a half miles along the stream, the outcrop of the Lower Freeport coal would be below the proposed flow line of reservoir, while for the remainder of the distance it would be well above, on account of the measures rising in that direction. The Upper Kittanning coal, it is understood, appears at stream bed in the lower portion of the site, but at other parts is some little distance below. It is said that the beds have from 30 inches to 36 inches of coal of fair quality.

About six miles of the branch railroad would come under flow line and a very small part of the village of Somerfield, which place is about one mile below the end of backwater.

Important Features.

Drainage area above dam	431 sq. mi.
Capacity of reservoir	648,800,000 cu. ft.
Height dam above stream	44 feet
Length of crest	635 "
Elevation of crest	1,360 "
Length of reservoir	7.6 miles
Average width	786 feet
Average depth	20.5 "
Area of surface	731 acres

Property Involved.

Land below flow line, 470 acres; marginal strip, 95 acres; total, 565 acres (20% wooded).

Somerfield: dwellings, 8. In other parts of the valley are the following, which have been in-

cluded in the estimate: dwellings, 3; barns, 2; 1 small coal mine; ordinary highway, 4.1 miles; railroad, 5.9 miles of branch line.

Estimate of Cost.

Dam		
Excavation	$ 13,700	
Concrete	183,300	
Riprap paving	1,500	
Gate house and appurtenances	19,500	
		$ 218,000
Land		17,400
Buildings		12,600
Railroads		225,000
Total		$ 473,000
Total, plus 15% for engineering and contingencies		543,900
Cost per million cubic feet of storage		838

Reservoir No. 2. (29).

The proposed location of the dam is at the Pennsylvania-Maryland state line, 13.1 miles above Confluence and 83.1 miles above the mouth. At the site of the dam solid rock is in view in the bed of the stream and outcroppings of sandstone and shale on both hillsides. The property below flow line is not of material importance, except that the railroad is again involved and the outcrops of two beds of coal varying in quality and ranging in thickness from 24 inches to 36 inches. These beds, judging from available knowledge, are the Upper and Lower Freeports and are between stream and flow line at the dam, while southwardly both rise until they get well above flow line about two-thirds up the project. The underlying Upper Kittanning would probably be under flow line for a short distance near the head of backwater.

An additional capacity of 983,600,000 cubic feet could be obtained at this site by increasing the height of the dam to 96 feet, but this storage was found to be unnecessary for flood control purposes, though it might later be found advisable for other purposes.

Important Features.

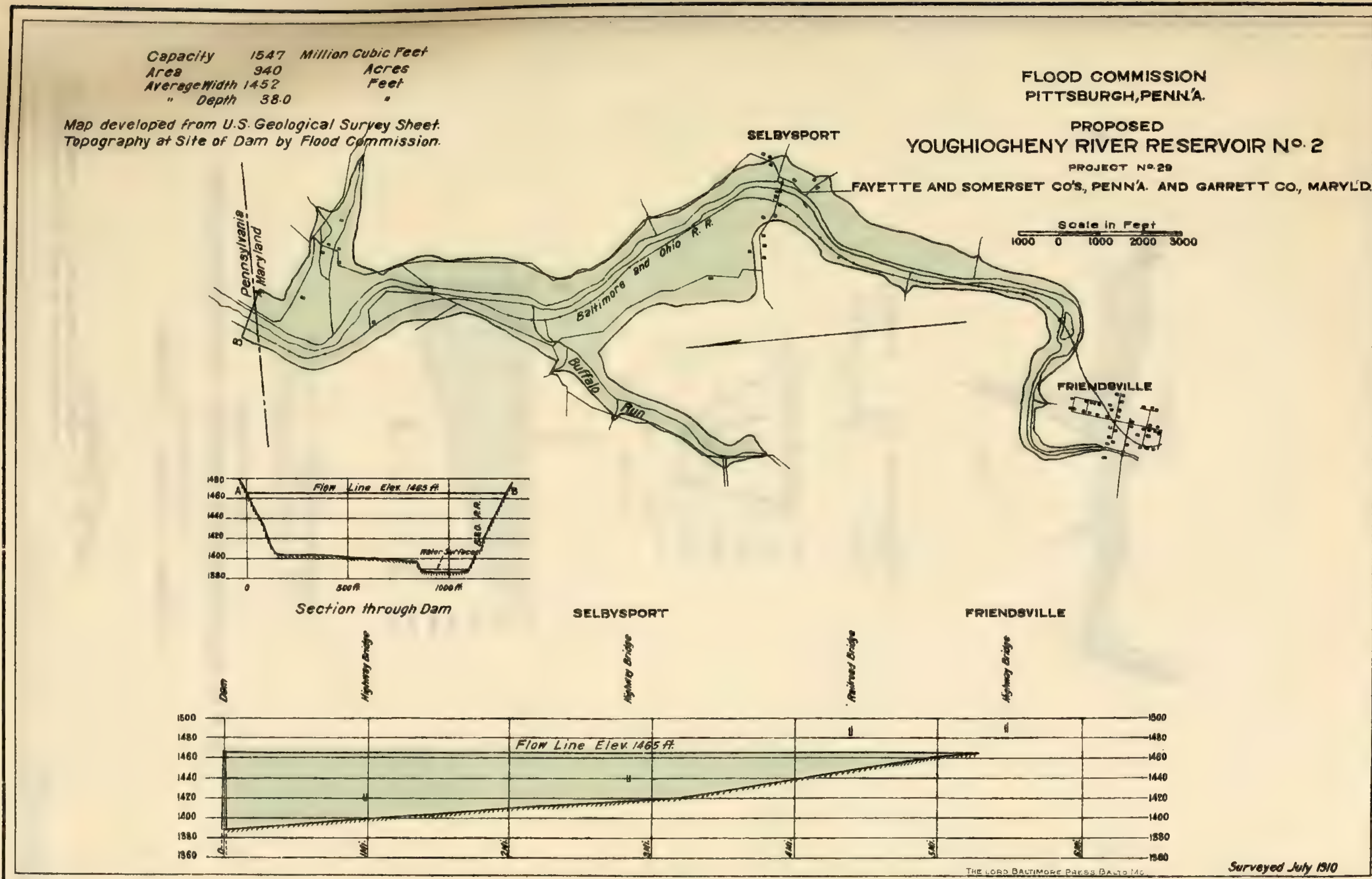
Drainage area above dam	394	sq. mi.
Capacity of reservoir	1,547,100,000	cu. ft.
Height dam above stream	76	feet
Length of crest	1,270	"
Elevation of crest	1,465	"
Length of reservoir	5.3	miles
Average width	1,452	feet
Average depth	38.0	"
Area of surface	940	acres

Property Involved.

Land below flow line, 797 acres; marginal strip, 68 acres; total, 865 acres (11% wooded).

Selbysport: dwellings, 10; barns, 4; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 15; barns, 6; grist mills, 1; 1 small coal mine; ordinary highway, 5.3 miles; railroad, 4.3 miles of branch line; railroad bridges, 1; highway bridges, 1.

PLATE 36



FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
YOUGHIOGHENY RIVER RESERVOIR No. 2
PROJECT No. 29
FAYETTE AND SOMERSET CO'S, PENN'A. AND GARRETT CO., MARYL'D.
Capacity 1547 Million Cubic Feet
Area 940 Acres
Average Width 1452 Feet
" Depth 38.0 "
Map developed from U.S. Geological Survey Sheet.
Topography at Site of Dam by Flood Commission.
Scale in Feet
1000 0 1000 2000 3000
SELBYSPORT
FRIENDSVILLE
Pennsylvania
Maryland
Baltimore and Ohio R. R.
Buffalo Run
Flow Line Elev. 1465 ft.
Water Surface
B.&O. R.R.
Section through Dam
SELBYSPORT
FRIENDSVILLE
Dam
Highway Bridge
Highway Bridge
Railroad Bridge
Highway Bridge
Flow Line Elev. 1465 ft.
Surveyed July 1910
THE LORD BALTIMORE PRESS BALTO MD.

Estimate of Cost.

Dam		
Excavation	$ 32,400	
Concrete	555,400	
Riprap paving	10,300	
Gate house and appurtenances	21,000	
		$ 619,100
Land		23,800
Buildings		16,100
Railroads		210,000
Total		$ 869,000
Total, plus 15% for engineering and contingencies		999,300
Cost per million cubic feet of storage		646

Reservoir No. 3. (30).

This project is located 20.1 miles above Confluence and 1.5 miles above Friendsville, and comes within a very rugged part of the valley. The average grade of the stream in this stretch is 52 feet to the mile, greater than on any of the other 42 projects. Estimates were made for rock footings across the length of dam, at very slight depth. Three coal beds, supposedly the Upper Kittanning and two lower seams, not well identified, would be submerged for distances varying from one to two miles. In thickness of coal, the beds average from 30 to 50 inches, and one of them has been mined near the stream, above the proposed site of dam. There are no other developments within this stretch except an old narrow-gage lumber railroad, which, it is said, is soon to be abandoned, as about all the marketable lumber has been cut.

By increasing the height of the dam to 160 feet, an additional capacity of 645,400,000 cubic feet could be obtained.

Important Features.

Drainage area above dam	291 sq. mi.
Capacity of reservoir	519,800,000 cu. ft.
Height dam above stream	110 feet
Length of crest	760 "
Elevation of crest	1,650 "
Length of reservoir	2.1 miles
Average width	839 feet
Average depth	52.5 "
Area of surface	227 acres

Property Involved.

Land below flow line, 184 acres; marginal strip, 30 acres; total, 214 acres (95% wooded).

Kendall: dwellings, 9; barns, 4; 1 combination tramway and highway bridge. In other parts of the valley are the following, which have been included in the estimate: coal mines, 3; ordinary highway, 0.5 mile; railroad, 2.0 miles of branch line.

Estimate of Cost.

Dam		
Excavation	$ 13,700	
Concrete	450,800	
Riprap paving	3,200	
Gate house and appurtenances	19,500	
		$ 487,200

Estimate of Cost.—(Continued.)

Land	$ 7,200
Buildings	8,400
Railroads	20,000
Total	$ 522,800
Total, plus 15% for engineering and contingencies	601,200
Cost per million cubic feet of storage	1,156

Reservoir No. 4. (31).

The dam for this project would be 25.6 miles from Confluence and 95.6 miles from the mouth of stream. Judging from what is known of the geology of this reach of the valley, there are no coal beds that would be affected by the reservoir. The only overflowed settlement is Sang Run, consisting of several small stores and a few unimportant dwellings. The lumber railroad continues along this part of the stream, ending a short distance above the head of the project.

This reservoir could be very considerably increased in capacity by raising the height of the dam to 158 feet, which would give an additional capacity of 2,609,800,-000 cubic feet.

Important Features.

Drainage area above dam	272 sq. mi.
Capacity of reservoir	1,170,400,000 cu. ft.
Height dam above stream	98 feet
Length of crest	625 "
Elevation of crest	2,040 "
Length of reservoir	6.1 miles
Average width	926 feet
Average depth	39.0 "
Area of surface	691 acres

Property Involved.

Land below flow line, 536 acres; marginal strip, 88 acres; total, 624 acres (50% wooded).

Along the valley are the following, which have been included in the estimate: dwellings, 14; barns, 9; ordinary highway, 1.7 miles; railroad, 5.9 miles of branch line; railroad bridges, 1; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 10,300	
Concrete	237,200	
Riprap paving	2,100	
Gate house and appurtenances	18,000	
		$ 267,600
Land		11,300
Buildings		13,900
Railroads		40,000
Total		$ 332,800
Total, plus 15% for engineering and contingencies		382,700
Cost per million cubic feet of storage		327

Reservoir No. 5. (32).

This is the uppermost site and the dam as proposed would have its location 34.6 miles above Confluence, 104.6 miles from the mouth of the stream and 21 miles below

PLATE 38

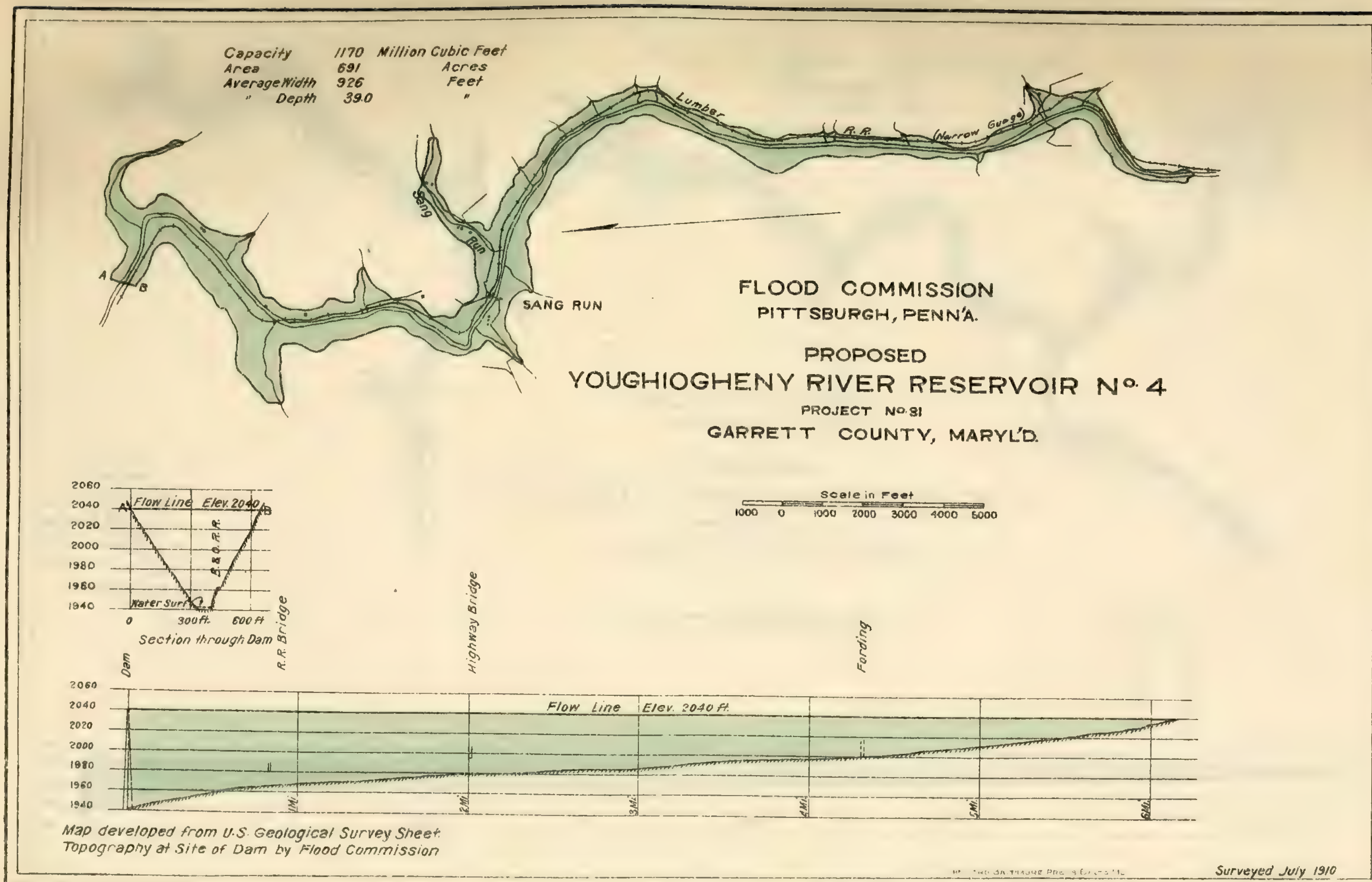
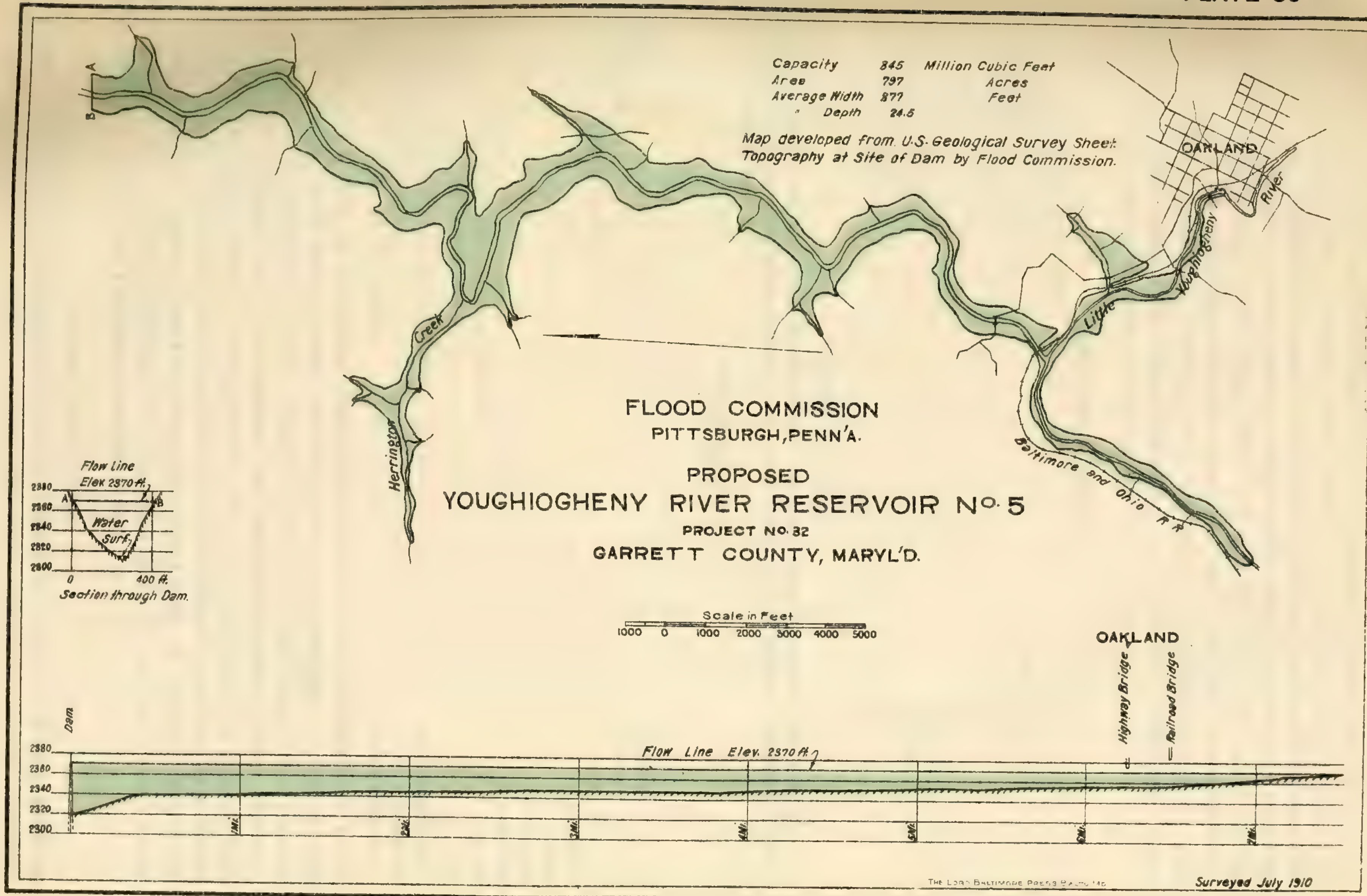

Capacity 1170 Million Cubic Feet
Area 691 Acres
Average Width 926 Feet
" Depth 39.0 "
Lumber
R.R.
(Narrow Guage)
Sang Run
SANG RUN
A
B
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
YOUGHIOGHENY RIVER RESERVOIR No. 4
PROJECT No. 31
GARRETT COUNTY, MARYL'D.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line Elev. 2040
B.&O.R.R.
Water Surf.
0 300 ft. 600 ft.
Section through Dam
Dam
R.R. Bridge
Highway Bridge
Fording
Flow Line Elev. 2040 ft.
2060
2040
2020
2000
1980
1960
1940
1 Mi.
2 Mi.
3 Mi.
4 Mi.
5 Mi.
6 Mi.
Map developed from U.S. Geological Survey Sheet
Topography at Site of Dam by Flood Commission
Surveyed July 1910

PLATE 39


Capacity 845 Million Cubic Feet
Area 797 Acres
Average Width 877 Feet
" Depth 24.5
Map developed from U.S. Geological Survey Sheet
Topography at Site of Dam by Flood Commission.
OAKLAND
Youghiogheny River
Little
Baltimore and Ohio R.R.
Herrington Creek
A
B
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
YOUGHIOGHENY RIVER RESERVOIR No. 5
PROJECT No. 32
GARRETT COUNTY, MARYL'D.
Flow Line
Elev. 2370 ft.
Water Surf.
2380
2360
2340
2320
2300
0
400 ft.
Section through Dam.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
OAKLAND
Highway Bridge
Railroad Bridge
Dam
Flow Line Elev. 2370 ft.
1 Mi.
2 Mi.
3 Mi.
4 Mi.
5 Mi.
6 Mi.
7 Mi.
Surveyed July 1910

the source. This reservoir is the highest of all the proposed projects, the elevation of its flow line being 2370 feet. It is also to be noted that it has the shortest crest of all the dams proposed. Solid rock appears in the stream bed and conditions indicate that throughout the remainder of the length of dam it can be found at a few feet below the present surface. The slope of the stream flattens off considerably in this reach, the rate being 7.3 feet per mile, which appears to be about the rise of the coal measures southwardly. The stream, instead of cutting down through, evidently flows over the rock surface of one of the strata. The Upper Kittanning coal bed, it is estimated, would be involved in the lower five miles of the project.

Important Features.

Drainage area above dam	160 sq. mi.
Capacity of reservoir	844,600,000 cu. ft.
Height dam above stream	55 feet
Length of crest	410 "
Elevation of crest	2,370 "
Length of reservoir	7.5 miles
Average width	877 feet
Average depth	24.5 "
Area of surface	797 acres

Property Involved.

Land below flow line, 756 acres; marginal strip, 130 acres; total, 886 acres (90% wooded).

Along the valley are the following, which have been included in the estimate: ordinary highway, 0.3 mile: highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 4,600	
Concrete	86,600	
Riprap paving	1,400	
Gate house and appurtenances	16,500	
		$ 109,100
Land		9,800
Total		$ 118,900
Total, plus 15% for engineering and contingencies		136,700
Cost per million cubic feet of storage		162
Total flood control capacity of five projects		4,730,700,000 cu. ft
Total cost of five projects		$2,663,800
Total maximum capacity of five projects		8,969,500,000 cu. ft.

The low-water flow of this stream during the summer months, especially in a dry year, is so small that water power without the aid of storage is not worthy of consideration. In each year, however, there are frequently high stages from which a large storage is obtainable, and it is believed that with the proposed group of reservoirs, or some of them, built, a development of commercial importance is possible with proper regulation. The most favorable location for utilization is at Ohio Pyle, where at one point, near the head of the falls, there is a direct drop of about 30 feet, while the total fall of the stream in a distance of about two miles is 95 feet, which could readily be increased to about 125 feet by suitable works.

LAUREL HILL CREEK.

Laurel Hill Creek, and practically its entire catchment area, is in the extreme western side of Somerset County. It rises a few miles west of the town of Somerset,

flows northeastwardly four miles, then turns abruptly to the left, following a rather direct southwesterly course, paralleling Laurel ridge, which is about four miles to the west, and, after traveling a distance of 30 miles, joins the Youghiogheny River at the town of Confluence, at an elevation of 1313 feet. As topographic surveys do not cover this basin, or in fact any of the others in Somerset County, little detailed information can be given.

The hills forming the divide surround the drainage area in the shape of a parallelogram, the extreme length of the basin being 22 miles, the average width about 6 miles and the area 128 square miles. The upper end of the basin reaches an altitude of not less than 2900 feet and the higher parts of the crest of Laurel ridge probably hold levels only slightly below this to a point near the Youghiogheny River, while the elevations of the eastern divide appear to be considerably lower. About 65 per cent of the drainage area, including the greater part of the western half of the basin, is wooded, but small areas on the flats of the immediate valley are under fair cultivation with occasional groups of maple trees and sugar camps. The banks of the stream are not thickly populated; in fact, no habitation whatever occurs on some reaches of great length; but on the lower portion, a railroad of small traffic has been extended to Humbert, 6 miles from Confluence, and at this place coal is mined for commercial purposes on a comparatively small scale and with apparently uncertain success, as the mine has not been worked for some time and the village is largely deserted. About four beds, running in thickness from thirty to forty inches, are said to be in the valley, several being of good quality, though, in places, somewhat distorted in form.

The maximum discharge at the mouth is estimated as 5800 second-feet, or 45.3 second-feet per square mile, while in extremely dry years, as in 1908, the stream goes dry. The difference between high and low water is about 16 feet.

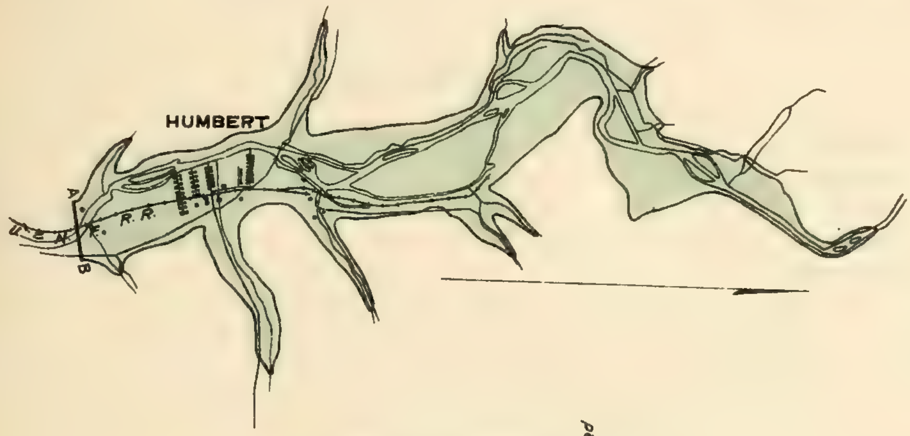
Reservoir Project. (22).

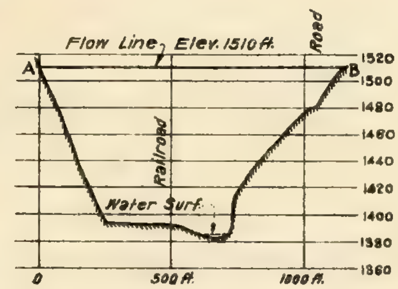
The mouth of the valley is wide, flat and cultivated, this condition reaching up the stream to Humbert, and the selection for the dam was made at the first favorable point, which is 5.2 miles above the mouth and 91 miles from Pittsburgh. The length of crest and height of dam are considerably over the average of those within the Monongahela watershed, but as the capacity secured is greater than the average, and the property damage is not unusually high, the project is considered a valuable addition to the control of the Youghiogheny River.

The mining village of Humbert would be totally involved, the dam being located only 0.5 of a mile below. About 1.5 miles of the railroad would come under flow line, as well as the Clarion coal bed for the entire length of the reservoir. This coal is said to be about thirty inches in thickness, dirty, and with the bed broken. The other coal beds, according to available data, are above the proposed level of the flow line.

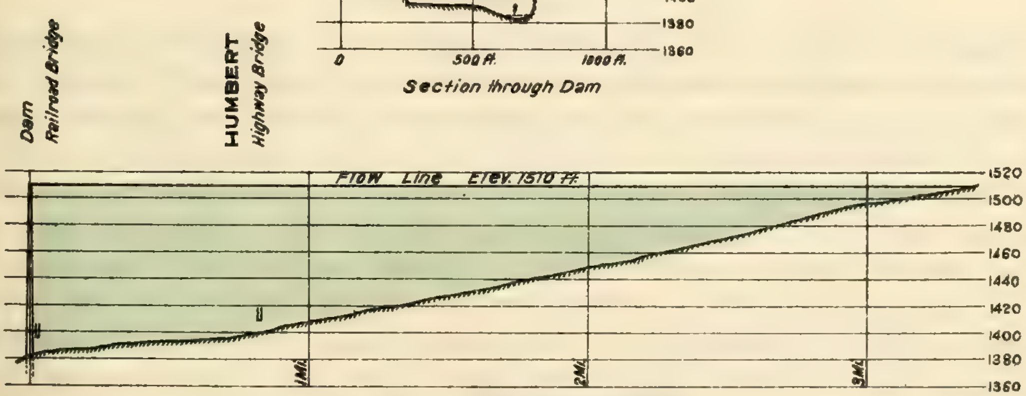
Important Features.

Drainage area above dam	114	sq. mi.
Capacity of reservoir	1,438,400,000	cu. ft.
Height dam above stream	125	feet
Length of crest	1,140	"
Elevation of crest	1,510	"
Length of reservoir	3.4	miles
Average width	1,357	feet
Average depth	59	"
Area of surface	561	acres





Section through Dam



Capacity	1438	Million Cubic Feet
Area	561	Acres
Average Width	1357	Feet
" Depth	59.0	"

FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED
LAUREL HILL CREEK RESERVOIR
PROJECT No. 22
SOMERSET COUNTY, PENN'A.

Scale in Feet
1000 0 1000 2000 3000

Control and Topography by Flood Commission
Surveyed July 1910.

The Lord Baltimore Press Balto Md

Property Involved.

Land below flow line, 503 acres; marginal strip, 57 acres; total, 560 acres (78% wooded).

Humbert: dwellings, 36; barns, 1; schools, 1; stores, 1; hotels, 1; power houses, 1; coal mines, 1; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 4; ordinary highway, 5.1 miles; railroad, 1.5 miles of branch line; railroad bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 28,500	
Concrete	817,800	
Riprap paving	9,200	
Gate house and appurtenances	20,300	
		$ 875,800
Land		10,800
Buildings		42,200
Highways		10,600
Railroads		99,000
Bridges		5,300
Total		$1,043,700
Total, plus 15% for engineering and contingencies		1,200,300
Cost per million cubic feet of storage		834

CASSELMAN RIVER.

The Casselman River rises in Garrett County, Maryland, in the point of convergence of Negro and Meadow Mountains, flows deeply set between these two ridges in a northeasterly course, entering the State of Pennsylvania 20 miles from the source, and after reaching the town of Meyersdale, turns to the northwest, and just to the east of Rockwood, rounds the northern limit of the main part of Negro Mountain, from which place it runs southwestwardly to the Youghiogheny at Confluence. The stream has a length of 60 miles, and falls from an elevation of 2740 feet to 1313 feet by three long reaches, the fall per mile of each being as follows: Source to the state line, 20 miles, 34.2 feet; thence to Markleton, 26 miles, 15.3 feet; then to the month, 14 miles, 24.6 feet.

About 57 per cent of the basin is under forest cover, most of this being on the steep slopes, which are of frequent occurrence in the thinly-settled parts, not only on many of the tributaries, but on the main stream. The lower coal measures obtain, at least throughout a large part of the basin, and are extensively mined in the Meyersdale vicinity and at other points along the upper portion of the valley.

The maximum discharge at the mouth is estimated to be 20,000 second-feet, or 44.6 second-feet per square mile, and the minimum 9 second-feet, or 0.02 second-foot per square mile. The difference between high and low water is 17 feet.

The main line of the Pittsburgh Division of the Baltimore & Ohio Railroad traverses 29.5 miles of the Casselman, from the mouth to Meyersdale, from which place it ascends Wills Creek, which is the main affluent. From Meyersdale a branch railroad extends a number of miles up the main stream. The Western Maryland Railroad is now building a line along the Casselman, paralleling the Baltimore & Ohio Railroad. The larger towns, or those which have been incorporated, and their respective populations are: Meyersdale, 3740; Salisbury Junction, 890; Garrett, 850; Rockwood, 1300; Casselman, 170. The last named is about 17 miles above the mouth.

The topography and the slope of the stream are favorable for storage on a large

scale above the Markleton vicinity, and there would be little interference with settlements if proper adjustment of flow line were made; but the damage to railroad property would make the projects too costly and it would very probably be impossible to make the necessary changes satisfactory to railroad requirements. The only part of the valley considered available is in the reach of twelve miles below Markleton, where, to secure a storage worthy of attention, it was necessary to form a group of reservoirs in five short and comparatively low steps, owing to the steepness of the stream and the railroads along the banks. The geological indications are that all the dams would have solid rock foundations, at depths ranging around five to eight feet.

The fourth reservoir from the mouth has the highest cost per million cubic feet of storage of any of the Monongahela projects, and in this feature is exceeded only by the Allegheny project, East Sandy, No. 2. The high unit cost of all five Casselman projects, the average being $2,127, is due to the small capacities that are obtainable, and indicates that storage along the available reach of the stream is not economical.

Reservoir No. 1. (23).

This project, the smallest of the group, would have its location 4.2 miles above the mouth of the stream and 89.8 miles from Pittsburgh. The mouth of the valley is wide, but at the place selected for the dam, a short distance above the small village of Harnedsville, the hills are reasonably close together and the railroads sufficiently high to permit of a structure of suitable height. No minable coals, so far as known, are within reach of any of the projects. It is to be noted that this reservoir is the shortest and has the lowest masonry dam of all the projects considered.

As there is no property of unusual value or worthy of special mention that would be involved on this project, nor on the others above, it seems unnecessary to go into detail further than to give the locations and important features of each reservoir. The sites are distant from the mouth as follows: No. 2, 5.3 miles; No. 3, 7.1 miles; No. 4, 9.3 miles; No. 5, 10.8 miles. The last project would have its dam immediately above the proposed crossing of the Western Maryland Railroad and the end of backwater would be a short distance below Markleton. The important features and estimated cost of reservoir No. 1 are as follows:

Important Features.

Drainage area above dam	408 sq. mi.
Capacity of reservoir	66,300,000 cu. ft.
Height dam above stream	29 feet
Length of crest	740 "
Elevation of crest	1,399 "
Length of reservoir	1.1 miles
Average width	583 feet
Average depth	19.5 "
Area of surface	77 acres

Property Involved.

Land below flow line, 50 acres; marginal strip, 15 acres; total, 65 acres (68% wooded).

Scattered throughout the valley are the following, which have been included in the estimate: dwellings, 1; barns, 1; saw mills, 1; small tramways, 1.

Casselman River, Pa., December, 1910.
View down stream, showing crest of proposed Dam No. 2.

Estimate of Cost.

Dam		
Excavation	$ 8,000	
Concrete	95,500	
Riprap paving	600	
Gate house and appurtenances	15,700	
		$ 119,800
Land		900
Buildings		1,600
Total		$ 122,300
Total, plus 15% for engineering and contingencies		140,700
Cost per million cubic feet of storage		2,122

Reservoir No. 2. (24).

Important Features.

Drainage area above dam	403 sq. mi.
Capacity of reservoir	99,600,000 cu. ft.
Height dam above stream	50 feet
Length of crest	610 "
Elevation of crest	1,440 "
Length of reservoir	1.8 miles
Average width	472 feet
Average depth	22.5 "
Area of surface	101 acres

Property Involved.

Land below flow line, 72 acres; marginal strip, 23 acres; total, 95 acres (90% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 2; saw mills, 1.

Estimate of Cost.

Dam		
Excavation	$ 8,000	
Concrete	161,600	
Riprap paving	600	
Gate house and appurtenances	15,700	
		$ 185,900
Land		800
Buildings		2,900
Total		$ 189,600
Total, plus 15% for engineering and contingencies		218,100
Cost per million cubic feet of storage		2,189

Reservoir No. 3. (25).

Important Features.

Drainage area above dam	389 sq. mi.
Capacity of reservoir	141,000,000 cu. ft.
Height dam above stream	56 feet
Length of crest	640 "
Elevation of crest	1,495 "
Length of reservoir	2.0 miles
Average width	488 feet
Average depth	27.0 "
Area of surface	120 acres

Property Involved.

Land below flow line, 85 acres; marginal strip, 24 acres; total, 109 acres (96% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 2; grist mills, 1; ordinary highway, 0.2 mile; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 9,100	
Concrete	182,700	
Riprap paving	700	
Gate house and appurtenances	15,700	
		$ 208,200
Land		800
Buildings		3,200
Highways		1,100
Bridges		13,900
Total		$ 227,200
Total, plus 15% for engineering and contingencies		261,300
Cost per million cubic feet of storage		1,853

Reservoir No. 4. (26).

Important Features.

Drainage area above dam	388 sq. mi.
Capacity of reservoir	119,800,000 cu. ft.
Height dam above stream	62 feet
Length of crest	710 "
Elevation of crest	1,562 "
Length of reservoir	1.5 miles
Average width	603 feet
Average depth	25.0 "
Area of surface	109 acres

Property Involved.

Land below flow line, 83 acres; marginal strip, 19 acres; total, 102 acres (85% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 2; barns, 1.

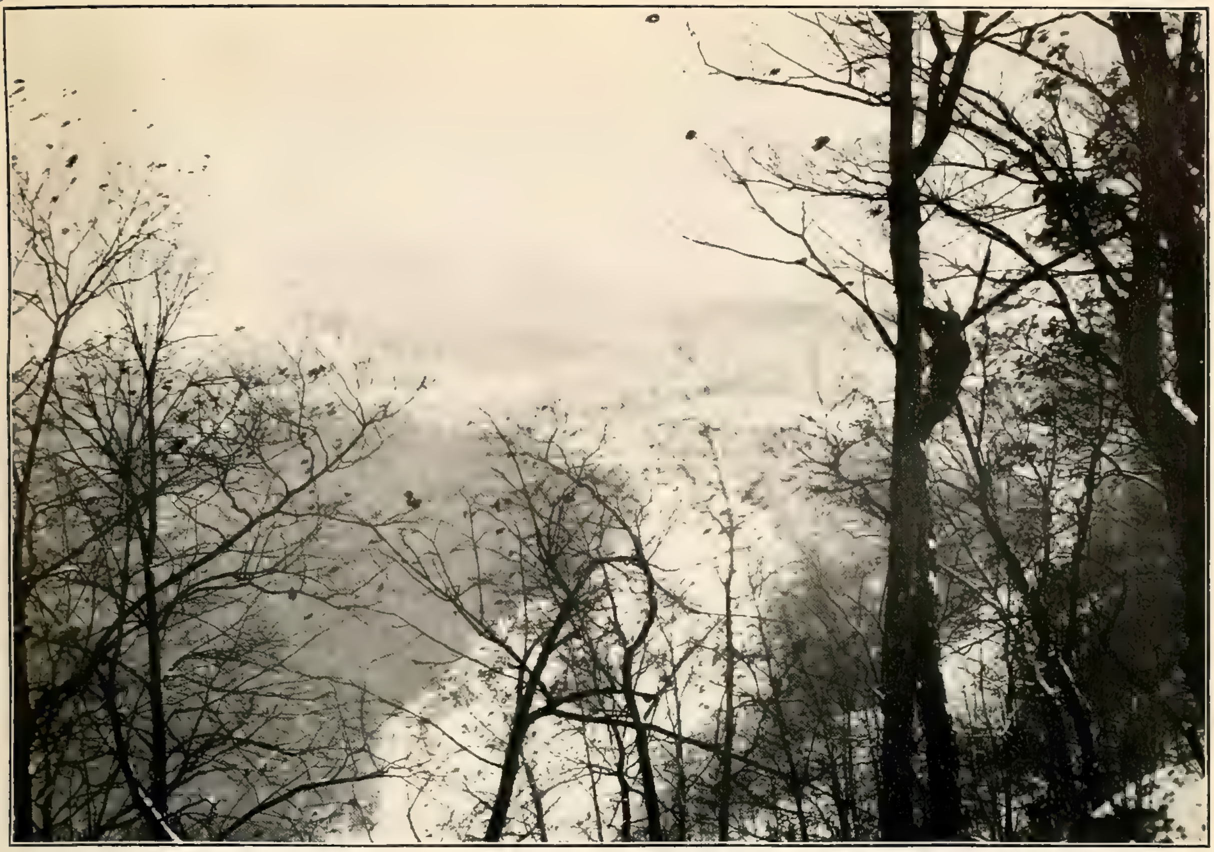
Estimate of Cost.

Dam		
Excavation	$ 10,200	
Concrete	225,900	
Riprap paving	800	
Gate house and appurtenances	15,700	
		$ 252,600
Land		900
Buildings		1,600
Total		$ 255,100
Total, plus 15% for engineering and contingencies		293,400
Cost per million cubic feet of storage		2,449

Reservoir No. 5. (27).

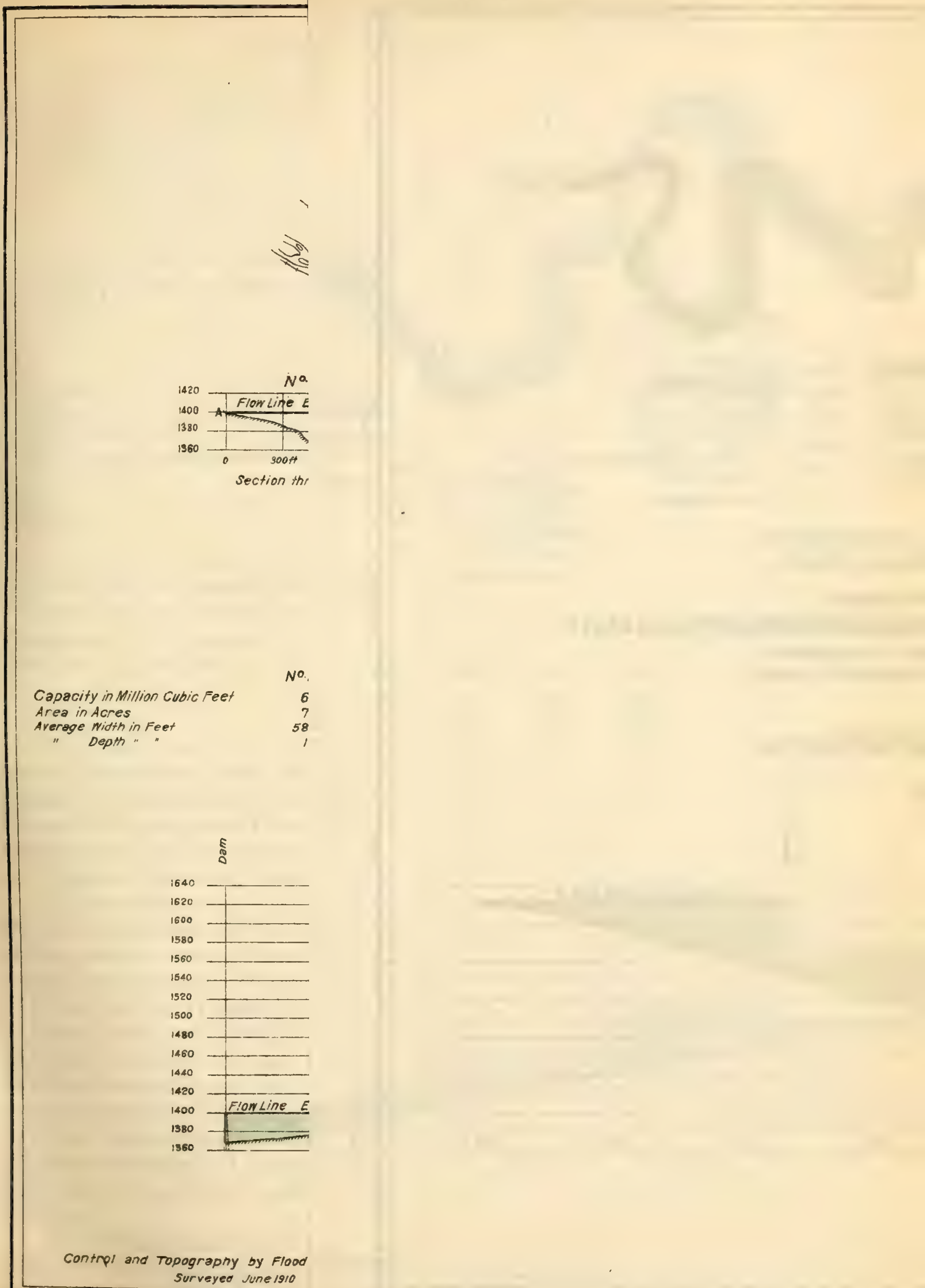
Important Features.

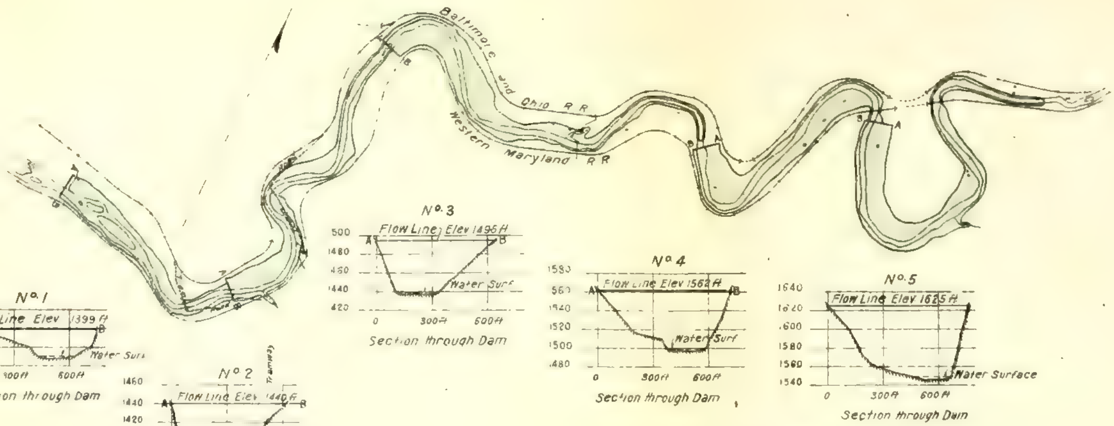
Drainage area above dam	383 sq. mi.
Capacity of reservoir	192,900,000 cu. ft.
Height dam above stream	75 feet

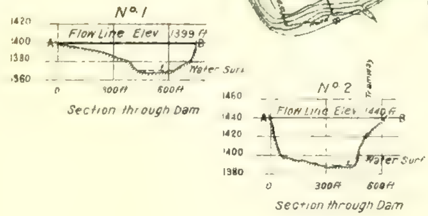


Casselman River, Pa., December, 1910.
View down stream, showing crest of proposed Dam No. 3.

Youghiogheny River, Md., December, 1910.
View up stream, from bridge just above Kendall.


No.
Flow Line E
1420
1400
1380
1360
0
300ft
Section thr
No.
Capacity in Million Cubic Feet 6
Area in Acres 7
Average Width in Feet 58
" Depth " " 1
Dam
1640
1620
1600
1580
1560
1540
1520
1500
1480
1460
1440
1420
1400
1380
1360
Flow Line E
Control and Topography by Flood
Surveyed June 1910



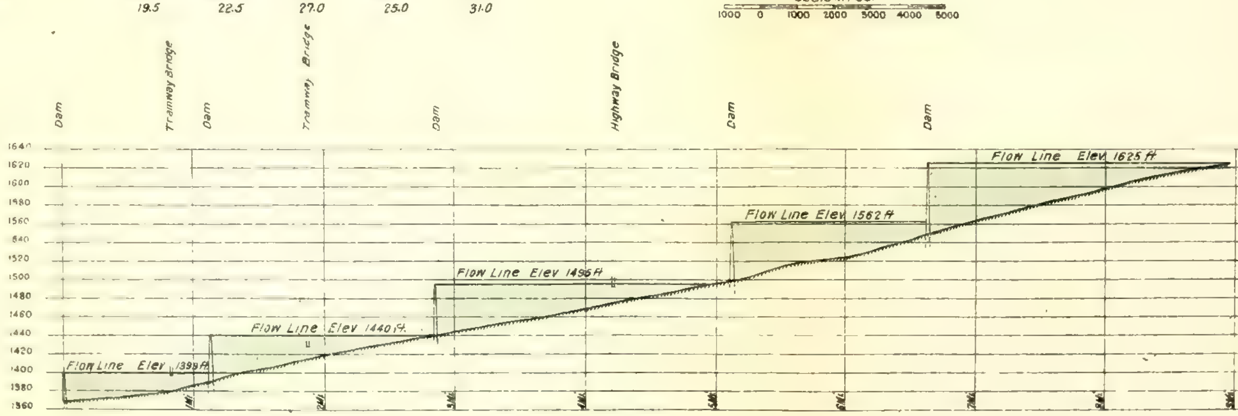


FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED
CASSELMAN RIVER RESERVOIRS Nos 1,2,3,4 AND 5
PROJECTS 23, 24, 25, 26 AND 27
SOMERSET COUNTY, PENN'A.

	Nº 1	Nº 2	Nº 3	Nº 4	Nº 5
Capacity in Million Cubic Feet	66	100	141	120	193
Area in Acres	77	101	120	109	143
Average Width in Feet	583	472	488	603	502
" Depth	19.5	22.5	27.0	25.0	31.0

Scale in Feet
1000 0 1000 2000 3000 4000 5000



Control and Topography by Flood Commission
Surveyed June 1910

Important Features.—(Continued.)

Length of crest	755 feet
Elevation of crest	1,625 "
Length of reservoir	2.4 miles
Average width	502 feet
Average depth	31.0 "
Area of surface	143 acres

Property Involved.

Land below flow line, 100 acres; marginal strip, 29 acres; total, 129 acres (85% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 2; barns, 2.

Estimate of Cost.

Dam		
Excavation	$ 12,400	
Concrete	318,400	
Riprap paving	900	
Gate house and appurtenances	15,800	
		$ 347,500
Land		1,100
Buildings		2,800
Total		$ 351,400
Total, plus 15% for engineering and contingencies		404,100
Cost per million cubic feet of storage		2,095
Total capacity of five projects		619,600,000 cu. ft.
Total cost of five projects		$1,317,600

CHEAT RIVER.

The Cheat River, or its uppermost branch, the Shavers Fork, rises in the northern part of Pocahontas County, West Virginia, and flows in a general northerly course, joining the Monongahela at Point Marion, in Pennsylvania, one mile north of the state line and 89.8 miles from Pittsburgh, by river channel. The source is in the point of coalescence of Back Allegheny Mountain and Cheat Mountain, high up on the slope at an altitude of 4500 feet, from which it falls to 780 feet at the mouth.

The aggregate length is 157 miles, the total fall 3720 feet, greater than any of the other tributaries, and the average fall per mile 23.6 feet. The fall per mile in long reaches, selected between material breaks in slope, is as follows: From source to the road at the settlement of Winchester, 19 miles, 50.0 feet; thence to proposed dam site of project No. 35, 53 miles, 33.7 feet; to Parsons, 7 miles, 20.1 feet; to Rowlesburg, 33 miles, 7.6 feet; to Albright, 14 miles, 13.2 feet; to mouth Big Sandy Creek, 11 miles, 24.8 feet; to mouth, 20 miles, 6.8 feet. The Cheat is formed by Shavers Fork and Dry Fork, which join at the town of Parsons, at an elevation of 1625 feet. There is a strong contrast between the general shape of the drainage basins of these two tributaries, the former being very long and narrow, and the latter notably fan-shaped. The only important branch of the Cheat proper is Big Sandy Creek, which enters on the right bank. An extensive water power development upon this creek has recently been chartered.

The drainage basin, which has an area of 1410 square miles, a full length of 102 miles, and an average width of 14 miles, drains portions of the following counties: Pocahontas, Randolph, Tucker, Barbour, Preston, Monongalia, in West Virginia, Fayette

in Pennsylvania, and a very small part of Garrett, Maryland. The topography over much of the basin is mountainous; in fact, practically all of the upland is rough, and many of the valleys have been formed into deep gorges, with swiftly flowing streams. Four mountain ranges cross the basin, the most southerly one being the Back Allegheny, and the next to the northwest, the Cheat. South of Parsons these two ranges form the Shavers Fork valley, the crest lines running parallel and very close together, the distance apart averaging only four miles. The elevation of the higher points varies from 4000 to 4800 feet, Bald Knob and Thorny Flat, at the head of the stream, reaching the latter altitude. Laurel ridge, with elevations of 2000 to 2600 feet, is passed through by the main stream below Rowlesburg, and Chestnut ridge, with about the same elevations, is deeply cut by the stream several miles above Mont Chateau. The latter range marks the beginning of the highly elevated country, while below that range, the surface of the upland is rolling, generally not reaching above 1100 feet.

Beginning at the head of Shavers Fork, it may be said that over half the length of the Cheat streamway lies in a narrow, steep-sided and uncultivated gorge, with the mountain slopes wooded on these reaches and along most of the remainder of the stream. Above Parsons, for a distance of a few miles, the valley opens out, here and there, with the stream flowing through low bottom land or flood plains. Below that town, for a distance of nine miles, to the village of St. George, the stream is crooked and the valley steep-sided and broad, widening in places to about half a mile across cultivated and unusually level bottoms. At and above Rowlesburg, narrow patches of cultivated bottom land obtain, and a similar condition exists below Mont Chateau, where the degree of cultivation is somewhat better. About half way up from Parsons, the Shavers Fork Valley has been cut down by the stream to a depth of nearly 2000 feet, the mountain top on the east being less than four-tenths of a mile distant. Below Albright, the precipitous sides have a fall of 1200 feet, in less distance. The Cheat possesses much natural beauty and the views obtained at such points as Coopers Rock, Cheat View and a number of places along the upper waters are notably fine.

About 69 per cent of the drainage area is under forest cover, which is fairly well scattered, but is most abundant on the higher elevations of the upper portion, the basins of the Dry Fork and Shavers Fork being respectively 77 per cent and 83 per cent wooded. This includes a number of tracts of virgin timber, aggregating an area of 221 square miles, as well as about 125 square miles of burned-over forest land. All but about 75 square miles of this virgin timber is located above Parsons, 43 square miles being on Shavers Fork, mainly in one large tract, and 103 square miles on the Dry Fork, in several tracts of considerable size.

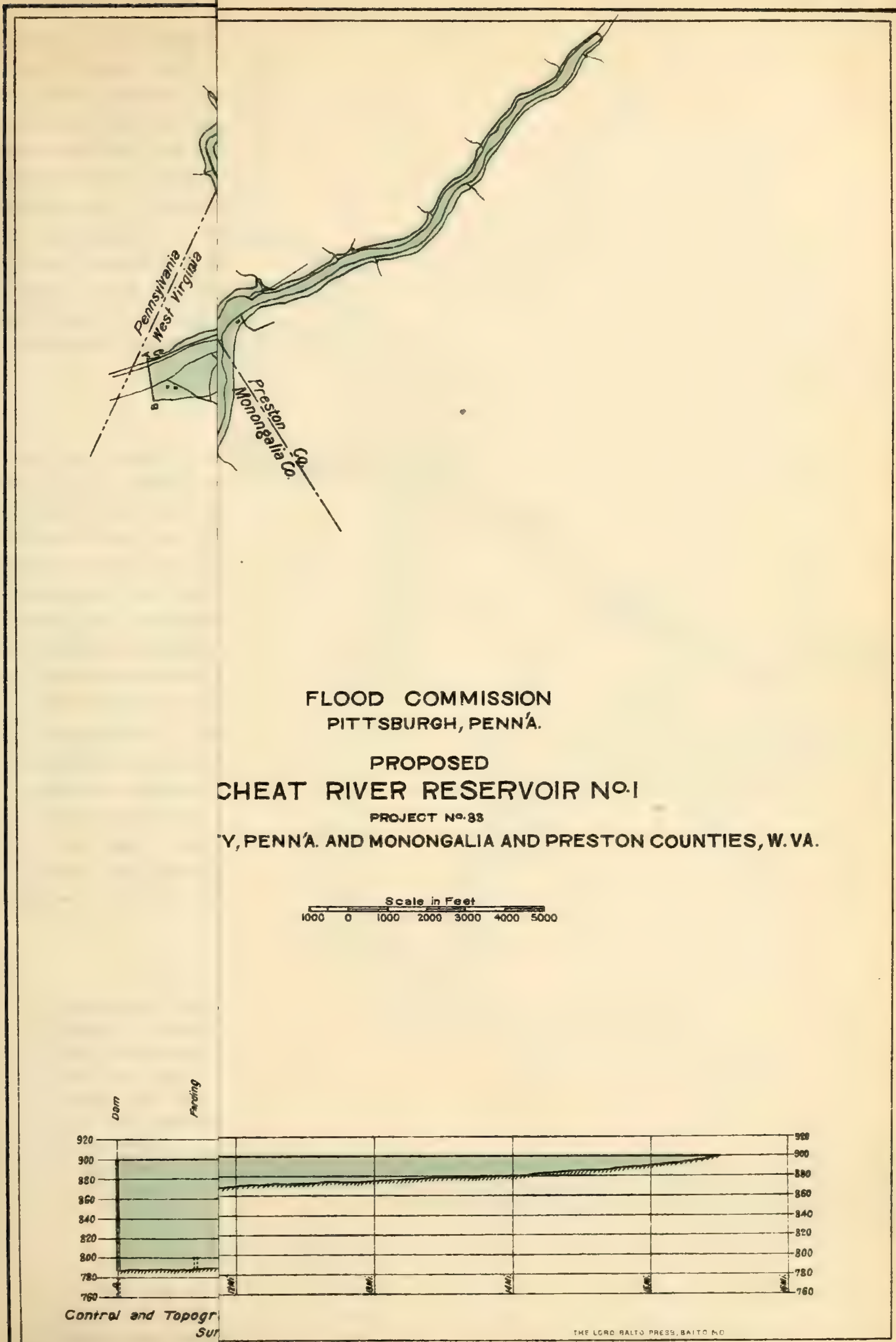
The geological formation along the valley contains coal, limestone and building stone. The Pittsburgh coal bed is mined high in the hill, near the Monongahela River, and several beds, geologically lower, cross the valley in two narrow belts, one at Mont Chateau and the other at Albright, the field width at the latter place being the greater, and covering about five miles of the stream. In the intervening part of the valley, according to available data, there is no coal, evidently due to the Chestnut ridge anticlinal having raised the measures high above the stream, resulting in the erosion of the strata. On the West Virginia map a field of considerable length is indicated on the Shavers Fork, but no description concerning it was noticed in the report of the Geological Survey of that state.

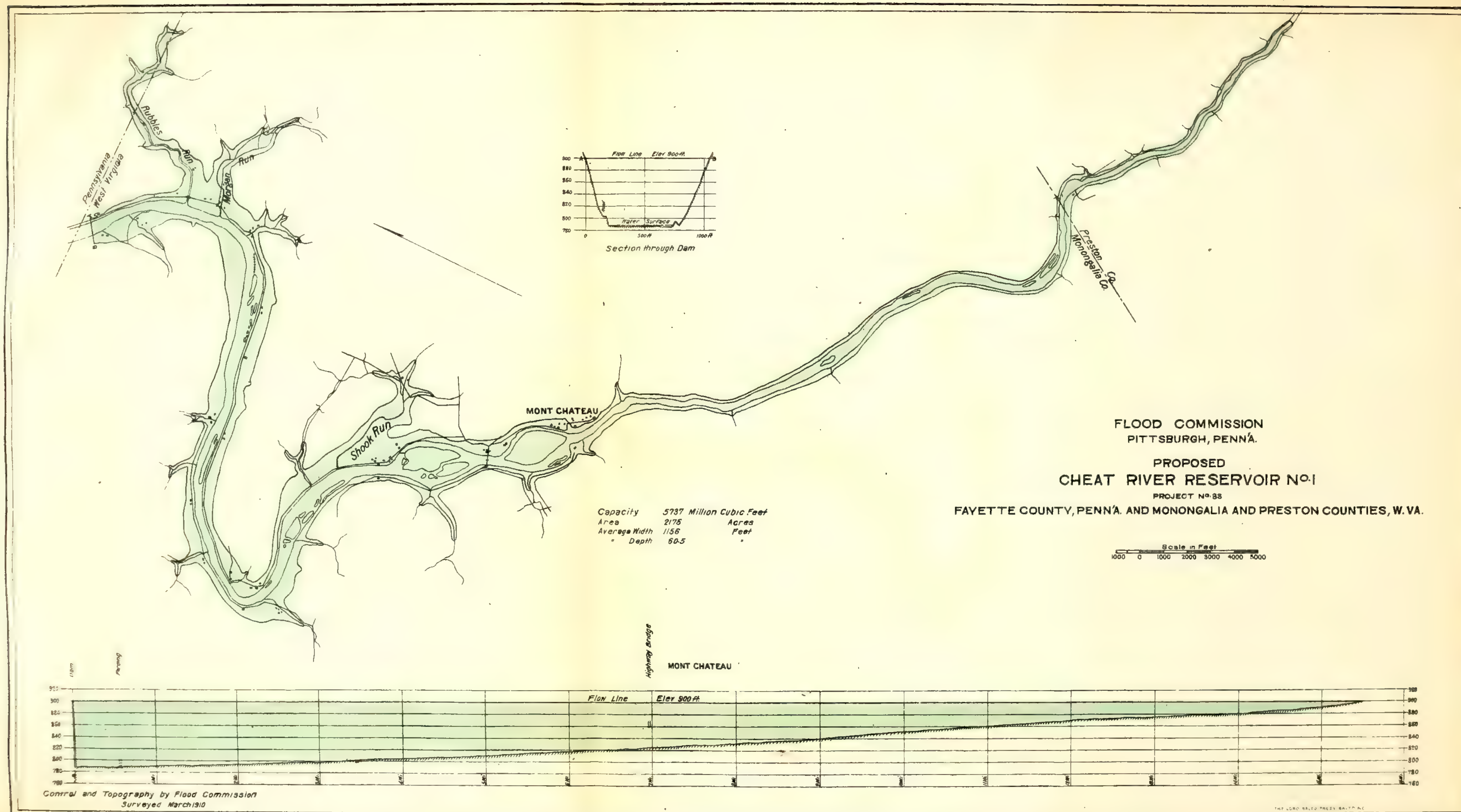
The maximum discharge at Uneva, W. Va., 10 miles above the mouth, from a drainage area of 1380 square miles, is estimated as 59,850 second-feet, or 43.3 second-feet per square mile, and the minimum, as 135 second-feet or 0.098 second-foot per

CHEAT RIVER, W. VA., DECEMBER, 1910.
View down stream, showing crest of proposed Dam No. 1.

Cheat River, W. Va., January, 1910.
View up stream, from Cheat Canyon Club House.

Cheat River, W. Va.
View up stream, from Coopers' Rock.


Pennsylvania
West Virginia
Preston Co.
Monongalia Co.
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CHEAT RIVER RESERVOIR No. 1
PROJECT No. 33
Y, PENN'A. AND MONONGALIA AND PRESTON COUNTIES, W. VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Dam
Parding
920
900
880
860
840
820
800
780
760
Control and Topogr
Sur
THE LORD BALTO PRESS, BALTO MD


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CHEAT RIVER RESERVOIR No. I
PROJECT No. 33
FAYETTE COUNTY, PENN'A. AND MONONGALIA AND PRESTON COUNTIES, W. VA.
Scale in Feet
Capacity 5737 Million Cubic Feet
Area 2175 Acres
Average Width 1156 Feet
" Depth 60.5 "
Section through Dam
Flow Line Elev 900 ft.
Water Surface
Pennsylvania
West Virginia
Rubbles Run
Morgan Run
Shook Run
MONT CHATEAU
Preston Co.
Monongalia Co.
Highway Bridge
Flow Line Elev 900 ft.
Control and Topography by Flood Commission
Surveyed March 1910

square mile. The difference between extreme high and low water stages is 23 feet.

The railroads entering the valley of the Cheat, and passing along close to the stream, are as follows: Baltimore & Ohio Railroad, from the mouth to Cheat Haven, 3 miles; Morgantown & Kingwood, Albright to Rowlesburg, 14 miles. The main line of the latter, east and west, crosses the valley at Rowlesburg. The towns of importance and their respective populations are as follows: Point Marion, 1390; Albright, 80; Rowlesburg, 940; Parsons, 1780.

The topography of this valley was found to be favorably formed for very large storage and complete flood control. The government maps were inspected and a field examination made all the way up to Parsons and including the lower reaches of Shavers Fork. Four sites were selected, surveyed and adopted, two of these being on the main stream below Parsons.

Reservoir No. 1. (33).

The dam would be located 3.5 miles from the mouth and would have a stream distance of 93.3 miles from Pittsburgh. Exposures on the steep hillside and the character of the river bed indicate that rock can be found at very slight depth, probably from four to six feet. A coal bed of nearly three feet thickness and apparently of no present mining value appears in the bank a short distance above the proposed dam. As the measures rise rapidly to the south, the bed would be well above reservoir flow line several miles upstream. The underlying Upper Freeport bed, occurring below Mont Chateau, about four feet thick, and said to be of poor quality, might be involved for a distance of nearly two miles. No other coal is present in the wild, narrow and rugged part of the valley along the project, above Mont Chateau.

The topography at this site is favorable for a storage exceeding 18,000,000,000 cubic feet, which could be obtained by a dam about 205 feet high. The maximum capacity available without interference with a private water power project planned on the Big Sandy tributary, however, is 10,118,100,000 cubic feet, which would require a dam 153 feet high. The studies showed it to be wise to cut this height down to 113 feet, reducing the capacity to 5,737,400,000 cubic feet, which, in combination with the other projects on this stream, is sufficient for flood control.

Important Features.

Drainage area above dam	1,399 sq. mi.
Capacity of reservoir	5,737,400,000 cu. ft.
Height dam above stream	113 feet
Length of crest	1,040 "
Elevation of crest	900 "
Length of reservoir	15.5 miles
Average width	1,156 feet
Average depth	60.5 "
Area of surface	2,175 acres

Property Involved.

Land below flow line, 1,461 acres; marginal strip, 228 acres; total, 1,689 acres (57% wooded).

Mont Chateau: dwellings, 4; barns, 3; bowling alleys, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 37; barns, 33; stores, 1; wagon shops, 1; ordinary highway, 13.1 miles; highway bridges, 1.

Estimate of Cost.

Dam		
Excavation	$ 32,200	
Concrete	892,600	
Riprap paving	3,300	
Gate house and appurtenances	50,800	
		$ 978,900
Land		48,200
Buildings		26,200
Highways		20,700
Bridges		45,900
Total		$1,119,900
Total, plus 15% for engineering and contingencies		1,287,900
Cost per million cubic feet of storage		224

Reservoir No. 2. (34).

This project would have its location about one mile above the main part of Rowlesburg, 45.7 miles above the mouth of the stream and 135.5 miles from Pittsburgh. The upper end of flow line reaches the village of St. George and the greater part of the intervening stretch of the valley is wooded, although here and there small flat areas have been cleared and are in cultivation or pasture. Geological conditions indicate that no coal obtains and rock can be found at about five feet, more or less, under ground surface at site of dam.

By increasing the height of the dam from 136 to 161 feet an additional capacity of 3,632,600,000 cubic feet could be obtained.

Important Features.

Drainage area above dam	928 sq. mi.
Capacity of reservoir	7,294,100,000 cu. ft.
Height dam above stream	136 feet
Length of crest	1,130 "
Elevation of crest	1,515 "
Length of reservoir	19.7 miles
Average width	1,237 feet
Average depth	56.5 "
Area of surface	2,961 acres

Property Involved.

Land below flow line, 2,163 acres; marginal strip, 268 acres; total, 2,431 acres (40% wooded).

Macomber: dwellings, 4; barns, 4. Hardesty: dwellings, 4; barns, 2; schools, 1; stores, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 51; barns, 27; schools, 2; stores, 1; saw mills, 3; cemeteries, 1; ordinary highway, 21.3 miles; highway bridges, 1.

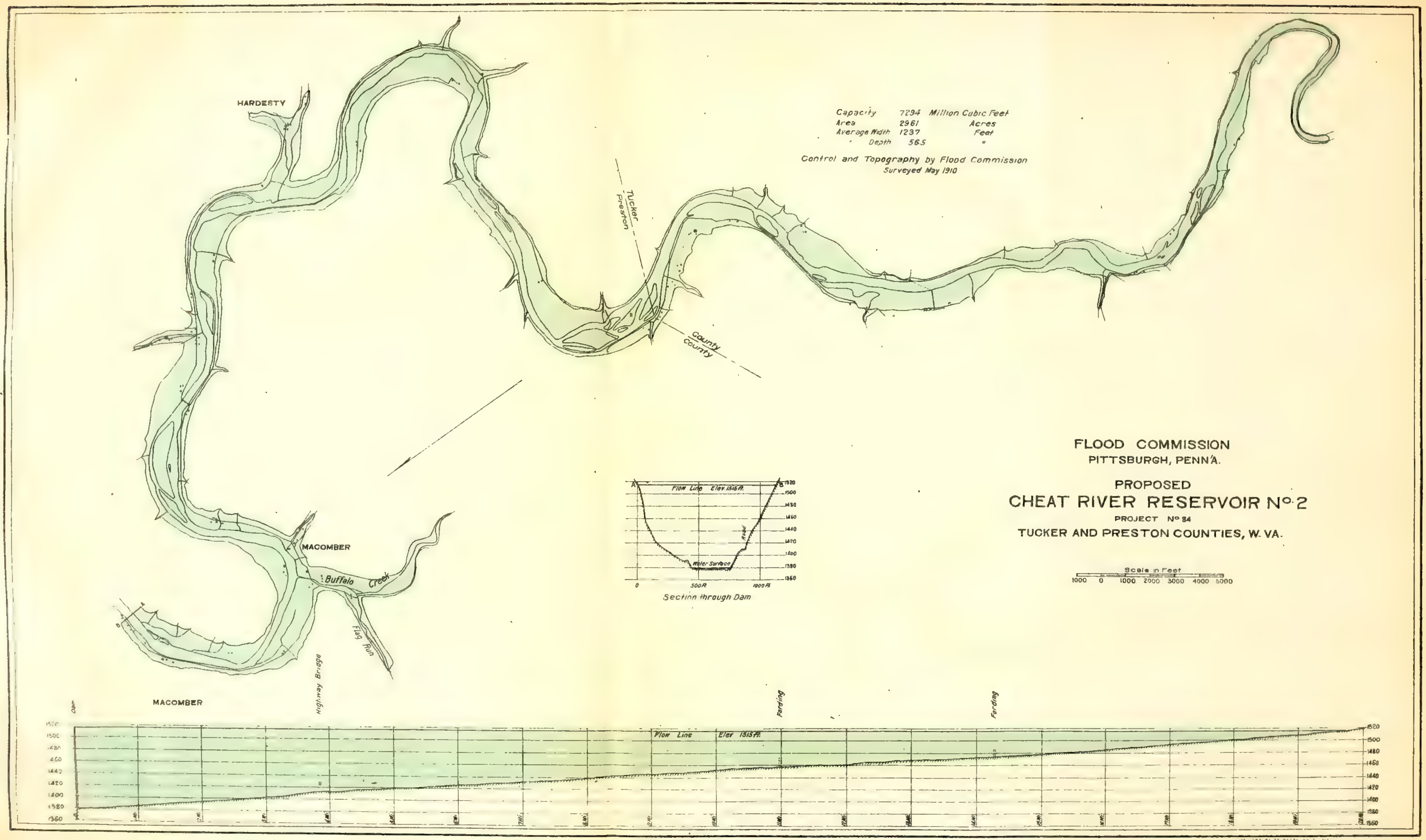
Estimate of Cost.

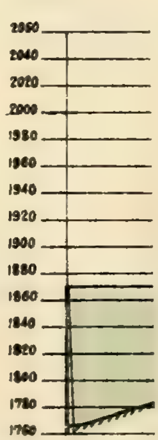
Dam		
Excavation	$ 34,500	
Concrete	1,152,400	
Riprap paving	7,000	
Gate house and appurtenances	53,700	
		$1,247,600

Cheat River, W. Va., December, 1910.
View down stream, showing crest of proposed Dam No. 2.

Cheat River, W. Va., December, 1910.
View up stream, from a point 3 miles above Rowlesburg.

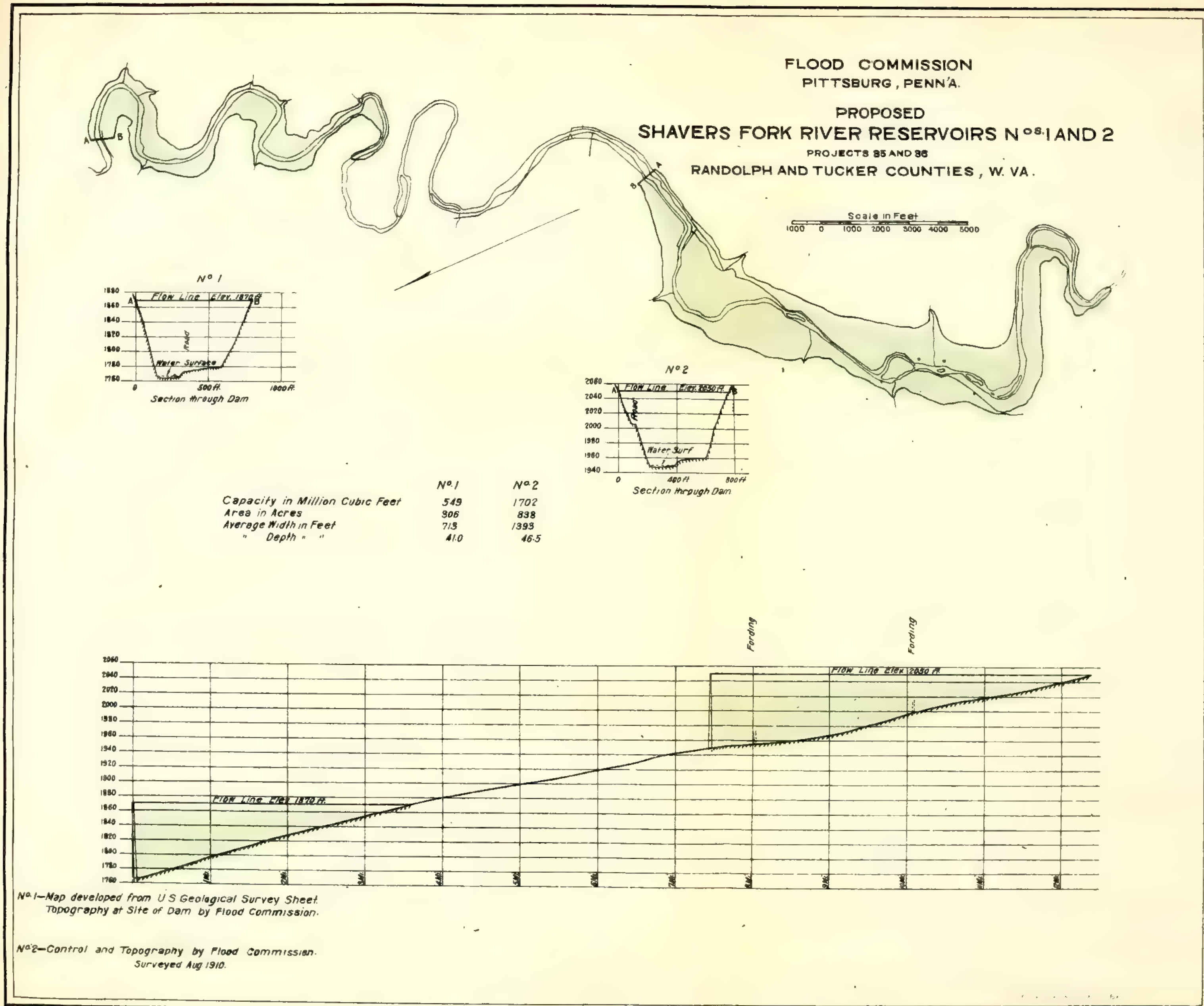

FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
AT RIVER RESERVOIR No. 2
PROJECT No. 34
KER AND PRESTON COUNTIES, W. VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
MACOM
Dam
1520
1500
1480
1460
1440
1420
1400
1380
1360


HARDESTY
Capacity 7234 Million Cubic Feet
Area 2961 Acres
Average Width 1237 Feet
" Depth 56.5 "
Control and Topography by Flood Commission
Surveyed May 1910
Tucker
Preston
County
County
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
CHEAT RIVER RESERVOIR No. 2
PROJECT No. 84
TUCKER AND PRESTON COUNTIES, W. VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Flow Line Elev. 1515 ft.
Water Surface
Road
Section through Dam
MACOMBER
Buffalo Creek
Flag Run
Highway Bridge
Dam
Fording
Fording
Flow Line Elev. 1515 ft.



No. 1—Map developed from U.S.
Topography at Site of Da

No. 2—Control and Topography
Surveyed


FLOOD COMMISSION
PITTSBURG, PENN'A.
PROPOSED
SHAVERS FORK RIVER RESERVOIRS N^os. 1 AND 2
PROJECTS 85 AND 86
RANDOLPH AND TUCKER COUNTIES, W. VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
N° 1
Flow Line Elev. 1870 ft.
Water Surface
Section through Dam
N° 2
Flow Line Elev. 2050 ft.
Water Surf.
Section through Dam
N° 1 N° 2
Capacity in Million Cubic Feet 549 1702
Area in Acres 306 838
Average Width in Feet 713 1393
" Depth " " 41.0 46.5
Fording
Fording
Flow Line Elev. 2050 ft.
Flow Line Elev. 1870 ft.
N° 1—Map developed from U.S. Geological Survey Sheet. Topography at Site of Dam by Flood Commission.
N° 2—Control and Topography by Flood Commission. Surveyed Aug 1910.

Estimate of Cost.—(Continued.)

Land	$ 36,900
Buildings	61,500
Highways	46,900
Bridges	104,400
Total	$1,497,300
Total, plus 15% for engineering and contingencies	1,721,900
Cost per million cubic feet of storage	236

SHAVERS FORK RESERVOIR NO. 1. (35).

The two sites on this stream form a part of the Cheat River system. The dam, as proposed, would be located 7.4 miles above the village of Parsons, and 175.2 miles from Pittsburgh. This section of the valley is thinly inhabited, and such developments as have been made are of small value. The hillsides are steep and rock ledges occur along the wooded slopes above the stream. The estimates have been made for rock footings at a depth of eight feet at the dam.

An additional capacity of 981,800,000 cubic feet could be obtained by increasing the height of the dam from 104 feet to 154 feet.

Important Features.

Drainage area above dam	179 sq. mi.
Capacity of reservoir	549,000,000 cu. ft.
Height dam above stream	104 feet
Length of crest	790 "
Elevation of crest	1,870 "
Length of reservoir	3.5 miles
Average width	713 feet
Average depth	41.0 "
Area of surface	306 acres

Property Involved.

Land below flow line, 253 acres; marginal strip, 42 acres; total, 295 acres (30% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 10; barns, 7.

Estimate of Cost.

Dam		
Excavation	$ 25,100	
Concrete	539,700	
Riprap paving	4,600	
Gate house and appurtenances	25,500	
		$ 594,900
Land		4,800
Buildings		15,500
Total		$ 615,200
Total, plus 15% for engineering and contingencies		707,500
Cost per million cubic feet of storage		1,288

SHAVERS FORK RESERVOIR NO. 2. (36).

This site, located 14.8 miles above Parsons and 182.6 miles from Pittsburgh, occurs in a part of the valley considerably broader than along the lower project, and the

topography permits of large economic storage. The bottom land, upon which there are a few small habitations, is under some cultivation, with portions in pasture, but, being flanked by steeply-rising hills, is difficult of access and of slight value. Masses of solid rock show prominently in the hills near the selected site of dam, and from inspection along the stream bed, rock surface was estimated to be at a depth of about 12 feet. The hills hold considerable heavy timber, which continues upstream into the gradually narrowing and frequently precipitous sided valley.

By increasing the height of the dam to 150 feet, an additional capacity of 2,318,500,000 cubic feet could be obtained.

Important Features.

Drainage area above dam	159 sq. mi.
Capacity of reservoir	1,701,500,000 cu. ft.
Height dam above stream	100 feet
Length of crest	760 "
Elevation of crest	2,050 "
Length of reservoir	4.9 miles
Average width	1,393 feet
Average depth	46.5 "
Area of surface	838 acres

Property Involved.

Land below flow line, 774 acres; marginal strip, 58 acres; total, 832 acres (55% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 7; barns, 6; schools, 1; ordinary highway, 3.7 miles.

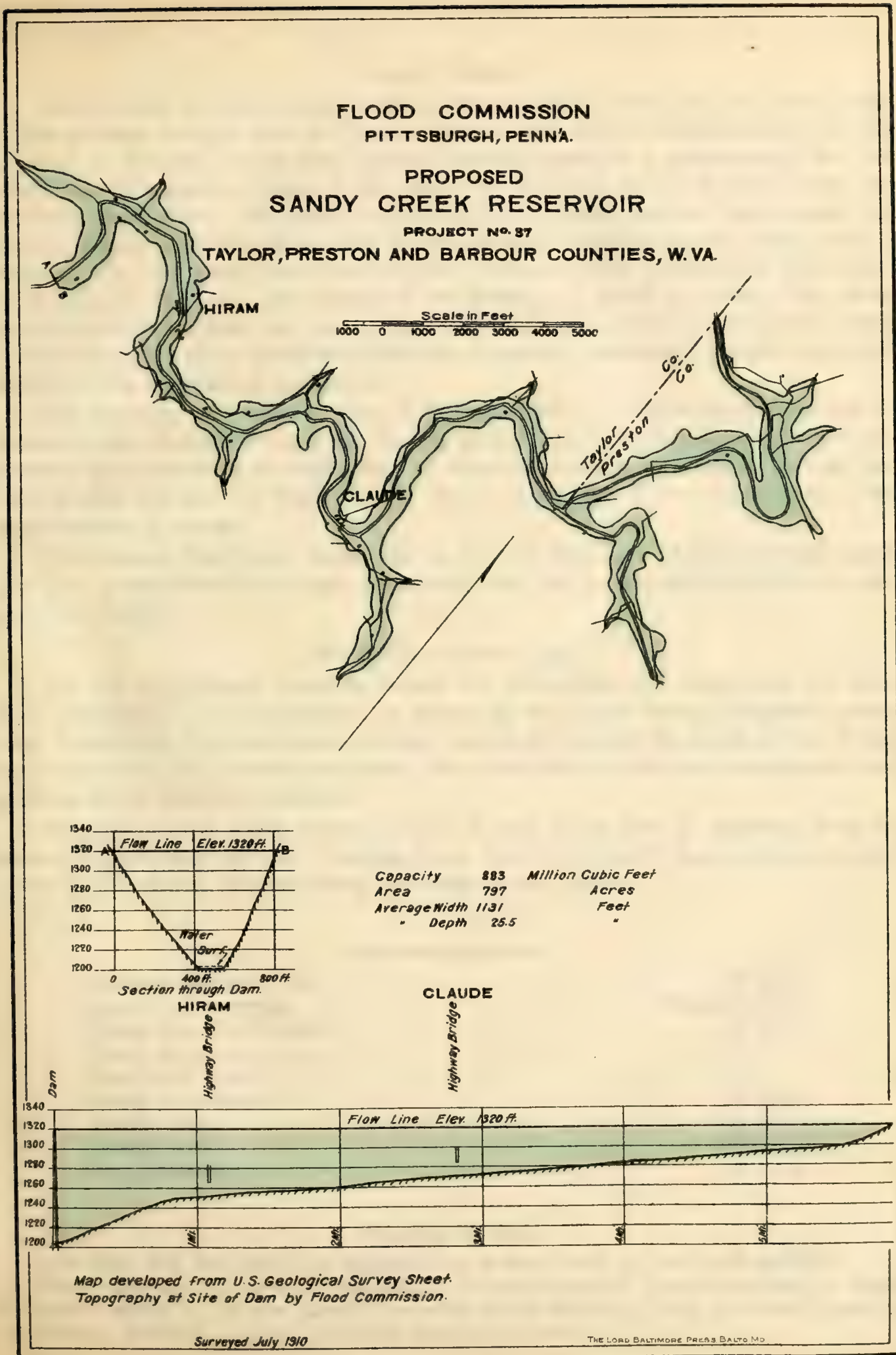
Estimate of Cost.

Dam		
Excavation	$ 15,600	
Concrete	491,800	
Riprap paving	3,700	
Gate house and appurtenances	24,000	
		$ 535,100
Land		11,100
Buildings		13,200
Total		$ 559,400
Total, plus 15% for engineering and contingencies		643,300
Cost per million cubic feet of storage		378
Total flood control capacity of four projects		15,282,000,000 cu. ft.
Total cost of four projects		$4,360,600
Total maximum capacity of four projects		26,595,600,000 cu. ft.

As shown above, there is considerably more storage capable of economic development along the Cheat than is necessary or has been adopted for flood control purposes. Should it later be decided to add to the proposed flood control storage, additional reservoir capacity to be used for impounding water for navigation and power purposes, the most favorable and effective location, or reach of stream, for power development would seem to be between a point about one mile below the village of Albright and Big Sandy Creek, where the total fall is 268 feet in ten miles, or at the rate of 26.8 feet to the mile. This part of the stream is narrow, with rock ledges, and practically devoid of any habitation, so that there would be no trouble in developing a large head by

Shavers Fork River, W. Va., December, 1910.
General view of valley at big bend below Lumber.

Shavers Fork River, W. Va., December, 1910.
View up stream, showing crest of proposed Dam No. 1.


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
SANDY CREEK RESERVOIR
PROJECT No. 37
TAYLOR, PRESTON AND BARBOUR COUNTIES, W. VA.
HIRAM
CLAUDE
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Taylor Co.
Preston Co.
Flow Line Elev. 1320 ft.
Water Surf.
Section through Dam.
Capacity 883 Million Cubic Feet
Area 797 Acres
Average Width 1131 Feet
" Depth 25.5 "
HIRAM
CLAUDE
Dam
Highway Bridge
Highway Bridge
Flow Line Elev. 1320 ft.
Map developed from U.S. Geological Survey Sheet.
Topography at Site of Dam by Flood Commission.
Surveyed July 1910
The Lord Baltimore Press Balto. Md.

one dam, or a group of two or more, which would back water over only a few miles of the stream.

SANDY CREEK.

Sandy Creek, the next stream to the north of Teters Creek, rises on Laurel ridge, in the extreme southern part of Preston County, and flows northwestwardly to the junction of Preston, Taylor and Barbour counties, thence in a southwesterly direction to the mouth, entering Tygart Valley River on the right bank, 28 miles from the mouth of that stream. The stream, in its length of 15 miles, has the high average fall of 93.0 feet per mile, the fall per mile in sections from the source to the mouth being as follows: To Cole Bank, two miles, 475 feet; thence to Dent, 5.0 miles, 26 feet; thence to Hiram, 4.7 miles, 14.5 feet; thence to the mouth, 3.3. miles, 74.8 feet. The elevation of the source is 2400 feet, and of the mouth 1005 feet. Little Sandy Creek, which is received at the above mentioned junction of counties, appears to form the main head-waters, so far as length is concerned.

The drainage basin, with an area of 87 square miles, a length of 15 miles and an average width of about 6 miles, lies for the greater part in Preston County, and is surrounded by a watershed the high points of which reach about 3000 feet at the head and 1600 to 1800 feet near the Tygart River. About 32 per cent of the basin, mostly in the upper portion, is wooded.

This stream, like Teters Creek, lies in the coal formation of the Allegheny series. The coal is not mined in a large, commercial way, but is used extensively by the people of the locality.

Reservoir Project. (37).

The site, as proposed, would be located 2.1 miles above the mouth and 158 miles from Pittsburgh. The topography, as shown by the United States Geological Survey map, is favorable for considerable storage, and at the time of the stadia survey, it was noted that solid rock formed the stream bed at the dam site, so that the estimates were made to accord with this condition.

The coal outcrop, which indicates a bed of four to six feet in thickness, does not show a high quality of coal. Judging from the best available data, about two miles of the coal would be involved along the valley by the project.

Important Features.

Drainage area above dam	85 sq. mi.
Capacity of reservoir	883,400,000 cu. ft.
Height dam above stream	116 feet
Length of crest	805 "
Elevation of crest	1,320 "
Length of reservoir	5.9 miles
Average width	1,131 feet
Average depth	25.5 "
Area of surface	797 acres

Property Involved.

Land below flow line, 739 acres; marginal strip, 72 acres; total, 811 acres (49% wooded).

Hiram: dwellings, 5; stores, 1; grist mills, 1; highway bridges, 1. Claude: dwellings, 4; stores, 1; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 4; barns, 2; ordinary highway, 5.5 miles.

Estimate of Cost.

Dam		
Excavation	$ 10,300	
Concrete	439,700	
Riprap paving	2,700	
Gate house and appurtenances	15,700	
		$ 468,400
Land		16,200
Buildings		12,500
Highways		10,600
Bridges		13,300
Total		$ 521,000
Total, plus 15% for engineering and contingencies		599,100
Cost per million cubic feet of storage		678

TETERS CREEK.

Teters Creek has its source on the slope of Laurel Ridge, at an elevation of 2300 feet, flows northwestwardly a distance of 14.5 miles and joins the Tygart Valley River on the right bank, 33 miles from the mouth, at an elevation of 1155 feet. The watershed has a greatest length of 11 miles and an average width of about 5 miles, enclosing an area of 53 square miles, most of which lies in the eastern part of Barbour County. The higher elevations of the divide range from 2900 feet, at the head of the stream, to about 1850 feet near the mouth. In the aggregate about 36 per cent of the basin is under forest cover. The immediate valley is developed only to a small degree and while coal obtains throughout the whole basin, none of it is mined commercially. The average fall of the stream is about 76.3 feet to the mile, and the fall of certain reaches is as follows: Source to Kirt, 3.5 miles, 140 feet; thence to Nestorville, 7.0 miles, 64 feet; thence to mouth, 4.0 miles, 54 feet.

Reservoir Project. (38).

The United States Geological Survey map formed the basis for the general study of this project, but was supplemented by a stadia survey at the site of dam and an inspection of the lower reaches of the stream. The point selected for the location of the dam is 1.2 miles above the mouth of the stream and 162 miles from Pittsburgh. The geological conditions indicate that rock foundation is obtainable throughout the entire length of the dam structure practically at ground surface. The coal of the valley is mined for home use and examination of the crop line indicates that it would not be involved by the project, as it is well above proposed flow line.

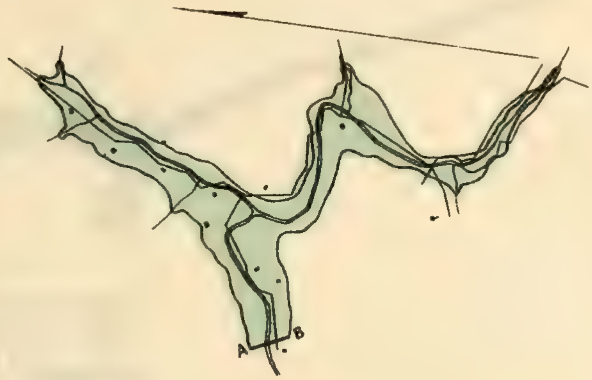
By increasing the height of the dam from 91 feet to 101 feet, an additional capacity of 122,300,000 cubic feet can be obtained, but this was considered unnecessary for flood control purposes.

Important Features.

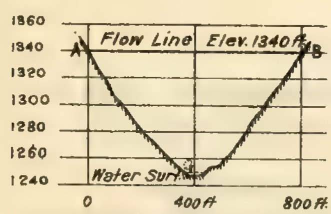
Drainage area above dam	49	sq. mi.
Capacity of reservoir	463,400,000	cu. ft.
Height dam above stream	91	feet
Length of crest	770	"
Elevation of crest	1,340	"
Length of reservoir	2.3	miles
Average width	938	feet
Average depth	40.5	"
Area of surface	263	acres

Buckhannon River, W. Va., November, 1910.
View up stream, showing crest of proposed dam.

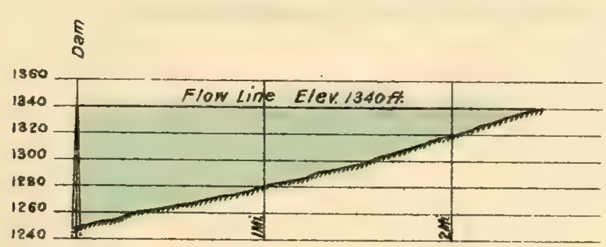
Teters Creek, W. Va., November, 1910.
View down stream, showing crest of proposed dam.



Capacity	463	Million Cubic Feet
Area	263	Acres
Average Width	938	Feet
" Depth	40.5	"



Section through Dam



FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED
TETERS CREEK RESERVOIR
PROJECT No. 38
BARBOUR COUNTY, W. VA.

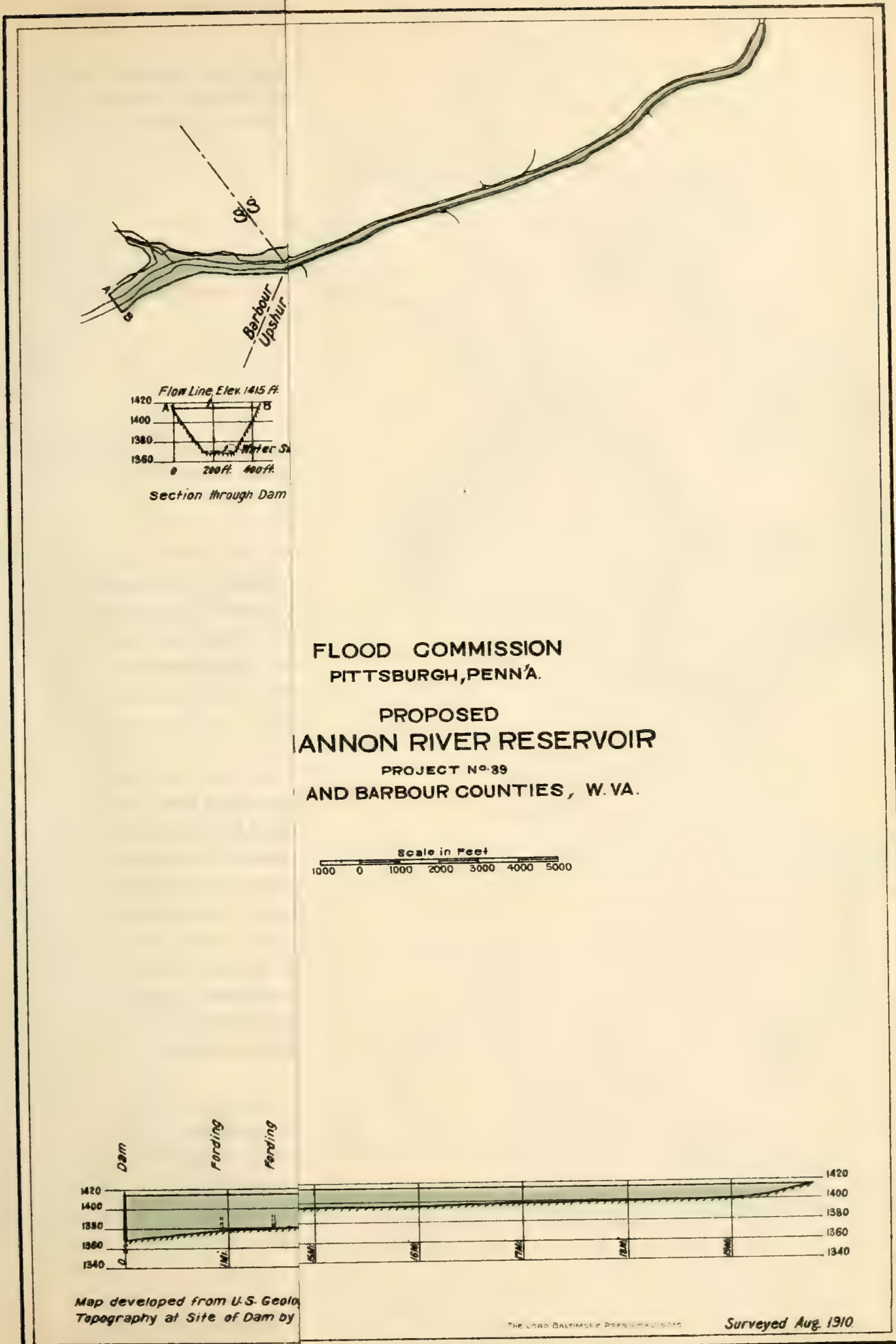
Scale in Feet
1000 0 1000 2000 3000

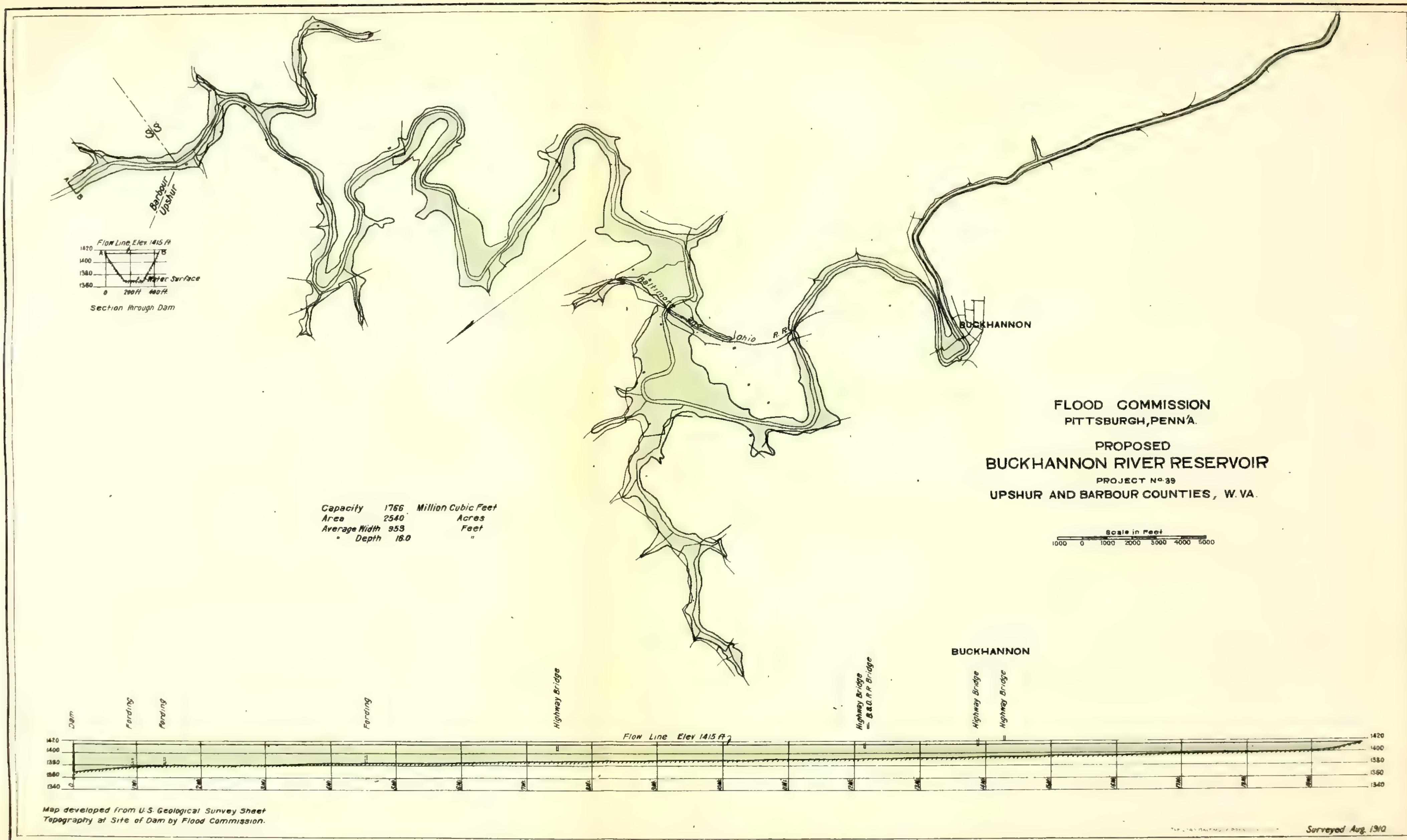
Map developed from U.S. Geological Survey Sheet.
Topography at Site of Dam by Flood Commission.

THE LORD BALTIMORE PRESS BALTO MD

Surveyed July 1910.

PLATE 47


Flow Line Elev. 1415 Ft.
Section through Dam
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
IANNON RIVER RESERVOIR
PROJECT No. 39
AND BARBOUR COUNTIES, W. VA.
Scale in Feet
Barbour
Upshur
Dam
Ferding
Ferding
Map developed from U. S. Geolo
Topography at Site of Dam by
Surveyed Aug. 1910.


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
BUCKHANNON RIVER RESERVOIR
PROJECT No. 39
UPSHUR AND BARBOUR COUNTIES, W. VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Capacity 1766 Million Cubic Feet
Area 2540 Acres
Average Width 953 Feet
" Depth 16.0 "
Flow Line Elev 1415 ft
Water Surface
0 200ft 400ft
Section through Dam
Barbour
Upshur
Baltimore and Ohio R.R.
BUCKHANNON
BUCKHANNON
Dam
Fording
Fording
Fording
Highway Bridge
Highway Bridge
B.&O.R.R. Bridge
Highway Bridge
Highway Bridge
Flow Line Elev 1415 ft
1420
1400
1380
1360
1340
Map developed from U.S. Geological Survey Sheet
Topography at Site of Dam by Flood Commission.
Surveyed Aug. 1910

Property Involved.

Land below flow line, 250 acres; marginal strip, 45 acres; total, 295 acres (30% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 2; barns, 1; ordinary highway, 3.5 miles.

Estimate of Cost.

Dam		
Excavation	$ 10,300	
Concrete	286,000	
Riprap paving	4,100	
Gate house and appurtenances	16,500	
		$ 316,900
Land		5,000
Buildings		1,900
Highways		18,500
Total		$ 342,300
Total, plus 15% for engineering and contingencies		393,700
Cost per million cubic feet of storage		841

BUCKHANNON RIVER.

Buckhannon River, the largest branch of the Tygart Valley River, flows northwardly a distance of 61 miles from its source on Turkey Bone Mountain, in the western part of Randolph County, falls from an elevation of 3400 feet and joins the Tygart Valley River 48 miles from the Monongahela, at Tygart Junction, at an elevation of 1320 feet. The length and fall per mile by long reaches is as follows: Source to Newton, 12.0 miles, 125.2 feet; thence to Alton, 6.5 miles, 15.1 feet; thence to Buckhannon, 18.0 miles, 22.4 feet; thence to Hall, 17 miles, 1.7 feet; thence to mouth, 7.5 miles, 6.4 feet.

The basin, with an area of 304 square miles, is immediately to the east of the upper West Fork, and drains portions of Randolph, Upshur and Barbour counties and a very small portion of Lewis County. The crest of the watershed, above the head of the stream, reaches an elevation of 4000 feet, gradually becoming lower on each side until the altitude is about 1800 feet near the mouth. About 37 per cent of the drainage area is under forest cover, practically all of which is in the upper half of the basin.

Coal is in the valley, but there is meager knowledge as to its structure or level, there being no active mining operations. From data obtained in the field, it is considered that the Upper Freeport coal is at very great depth under water, probably 200 feet and over. A coal of very doubtful mining value, lying above the Freeport, is thought to have a horizon which would cause it to be involved by the reservoir for a distance of nearly two miles.

The stream is closely followed by the Buckhannon & Tygart Valley branch of the Baltimore & Ohio Railroad, from the mouth to a point about one mile below the village of Hall, from which place it extends back into the country, again joining the stream near the town of Buckhannon. From this town, close along the stream, is located the West Virginia & Pittsburgh Railroad. The only incorporated town and the only one of importance is Buckhannon, which has a population of 2230.

RESERVOIR PROJECT. (39).

The project was studied from the United States Geological Survey map, supplemented by a field inspection of the Flood Commission and a line of levels along the en-

tire reach of valley under question, together with a stadia survey made at the site of the dam. The site selected for the dam is about one mile above Hall, 8.2 miles above the mouth and 185 miles from Pittsburgh. Rock foundation is obtainable practically at ground surface. Much of the upland country is under cultivation, but along a considerable part of the lower half of the reservoir section, the immediate valley is narrow, with steep, brushy hillsides. Just below Buckhannon, it widens out, with low, flat land. The developments coming under proposed flow line are of small importance. The pool level was adjusted to avoid material damage at the town of Buckhannon. This reservoir has the lowest cost per million cubic feet of storage of all the projects under consideration.

Important Features.

Drainage area above dam	273 sq. mi.
Capacity of reservoir	1,765,700,000 cu. ft.
Height dam above stream	45 feet
Length of crest	420 "
Elevation of crest	1,415 "
Length of reservoir	19.9 miles
Average width	953 feet
Average depth	16.0 "
Area of surface	2,540 acres

Property Involved.

Land below flow line, 2,130 acres; marginal strip, 241 acres; total, 2,371 acres (93% wooded).

Scattered through the valley are the following, which have been included in the estimate: dwellings, 4; ordinary highway, 5.0 miles; highway bridges, 4.

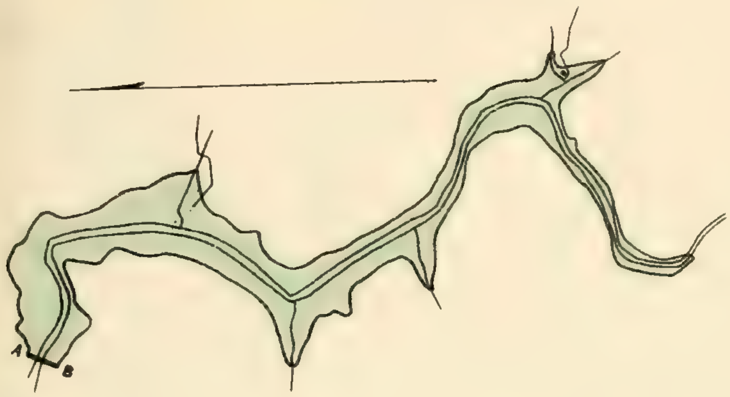
Estimate of Cost.

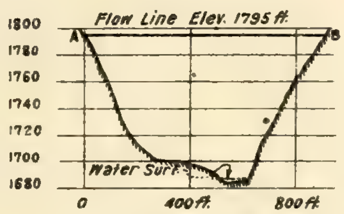
Dam		
Excavation	$ 5,800	
Concrete	98,100	
Riprap paving	1,200	
Gate house and appurtenances	39,500	
		$ 144,600
Land		19,600
Buildings		2,500
Highways		5,300
Total		$ 172,000
Total, plus 15% for engineering and contingencies		197,800
Cost per million cubic feet of storage		112

MIDDLE FORK RIVER.

Middle Fork, which is located next to the east of the Buckhannon, rises in the western part of Randolph County, and flows northwardly 38 miles, joining the Tygart Valley River 52 miles from its mouth and 7.8 miles below the town of Belington, in Barbour County. From an elevation of about 3000 feet at the source, it falls at the average rate of 39.5 feet per mile to an elevation of 1498 feet at the mouth. From the source to West Hultonville, the rate per mile for 6 miles is 100 feet; thence to Midvale, 18 miles, 30.6 feet; thence 9.5 miles, 12.6 feet; thence 4.5 miles, 52 feet.

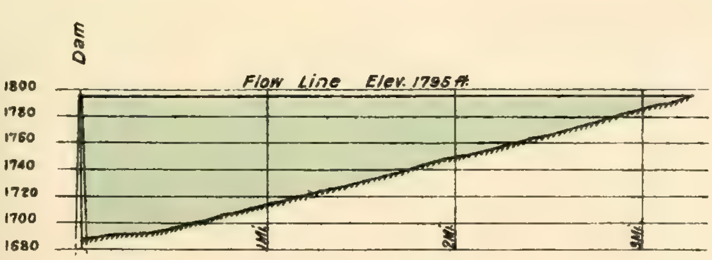
The basin, with a length of 28 miles and an average width of 5.4 miles, drains an area of 152 square miles and is confined by a watershed the high parts of which vary in elevation from 3900 feet, at the head, to 2100 feet near the mouth. The stream





Section through Dam

Capacity	554	Million Cubic Feet	
Area	307		Acres
Average Width	777		Feet
" Depth	41.5		"



FLOOD COMMISSION
PITTSBURGH, PENN'A.

PROPOSED

MIDDLE FORK RIVER RESERVOIR No. 1

PROJECT No. 40

BARBOUR AND UPSHUR COUNTIES, W. VA.

Scale in Feet
1000 0 1000 2000 3000

Map developed from U.S. Geological Survey Sheet
Topography at Site of Dam by Flood Commission.

The Lord Baltimore Press Balto. Md.

Surveyed Aug. 1910.

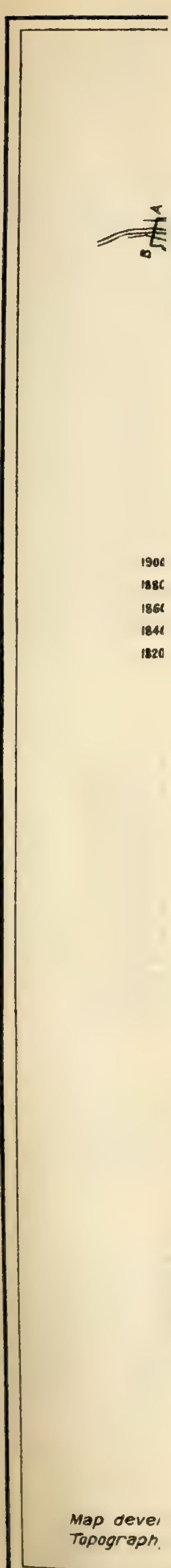
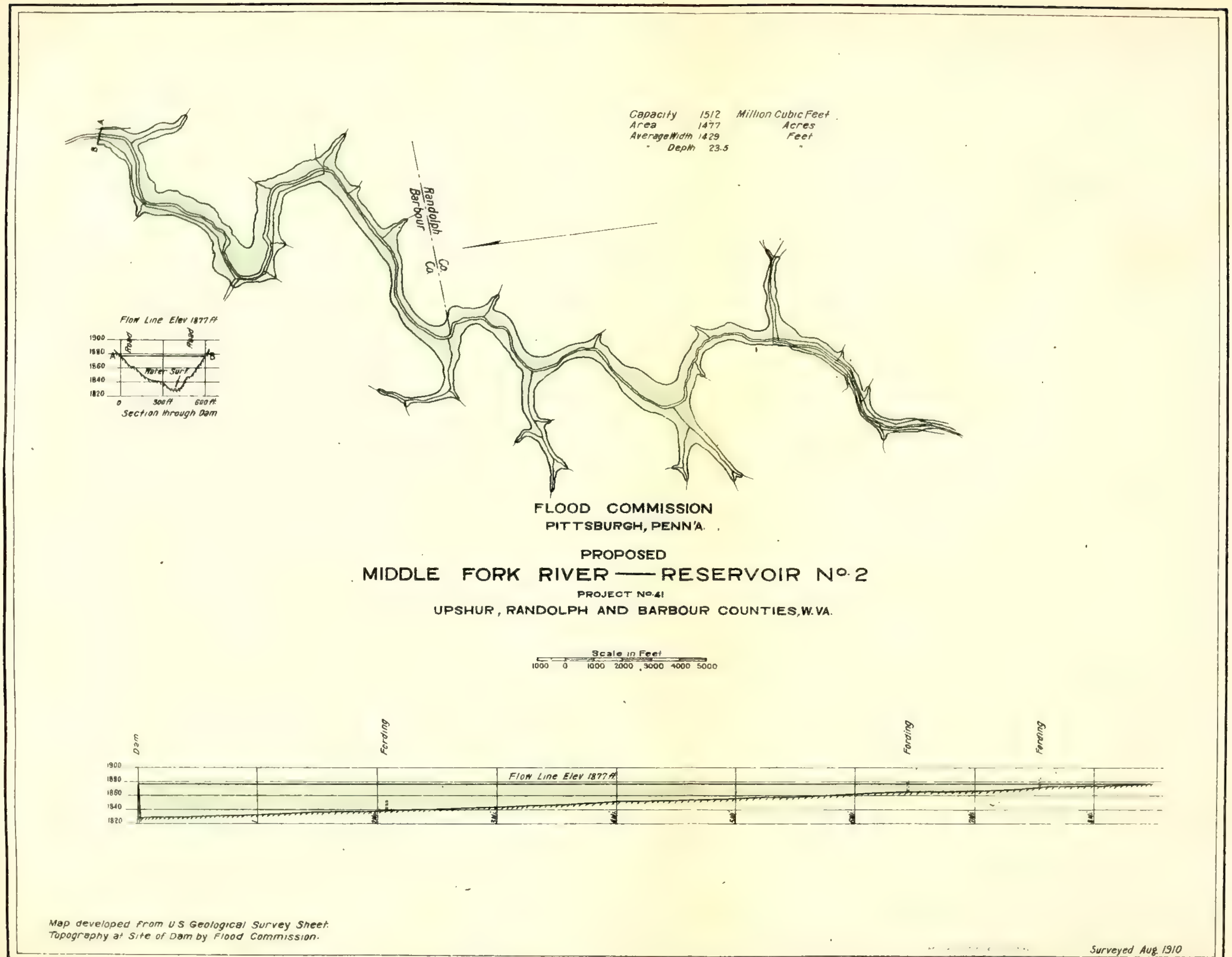

1900
1880
1860
1840
1820
Map deve
Topograph

PLATE 49



Capacity 1512 Million Cubic Feet
Area 1477 Acres
Average Width 1429 Feet
" Depth 23.5 "
Randolph Co.
Barbour Co.
Flow Line Elev 1877 ft
Road
Road
Water Surf.
Section through Dam
FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
MIDDLE FORK RIVER — RESERVOIR No. 2
PROJECT No. 41
UPSHUR, RANDOLPH AND BARBOUR COUNTIES, W.VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Dam
Fording
Fording
Fording
Flow Line Elev 1877 ft
1900
1880
1860
1840
1820
Map developed from U.S. Geological Survey Sheet.
Topography at Site of Dam by Flood Commission.
Surveyed Aug. 1910

flows through a narrow, rugged and thinly-inhabited valley, the slopes of which are fairly well wooded, while near the headwaters there is a considerable tract of virgin forest, amounting to about 30 square miles. About 58 per cent of the drainage area, mostly in the upper half, is wooded.

The topography being favorable, two sites were selected in the lower portion of the stream and studied from the United States Geological Survey map. Stadia surveys were made at the site of each dam and the valley generally inspected. Rock foundation is available in the bed of the stream at both sites, and estimates have been made accordingly. Coal of the Allegheny River strata is found along the stream, but there is little definite knowledge as to its position. It is seen at water level, however, about three miles above the site of the dam of Project No. 2, and it is considered that this would be the only bed involved, and that only to limited extent in this one reservoir. Another coal bed is in the hill, high above flow line.

By increasing the height of the dam to 142 feet, an additional capacity of 842,300,000 cubic feet could be obtained in reservoir No. 1. The capacity of reservoir No. 2 could likewise be increased by 962,200,000 cubic feet by making the dam 60 feet high. It is immediately evident from a comparison of the main features and cost per million cubic feet of each of the two reservoirs, that the site of No. 2 is considerably more favorable for economical storage.

Reservoir No. 1. (40).

Important Features.

Drainage area above dam	147 sq. mi.
Capacity of reservoir	554,000,000 cu. ft.
Height dam above stream	107 feet
Length of crest	900 "
Elevation of crest	1,795 "
Length of reservoir	3.2 miles
Average width	777 feet
Average depth	41.5 "
Area of surface	307 acres

Property Involved.

Land below flow line, 292 acres; marginal strip, 40 acres; total, 332 acres (97% wooded). Only one dwelling would come under the flow line of the proposed reservoir.

Estimate of Cost.

Dam		
Excavation	$ 14,900	
Concrete	480,900	
Riprap paving	5,600	
Gate house and appurtenances	18,800	
		$ 520,200
Land		2,100
Buildings		800
Total		$ 523,100
Total, plus 15% for engineering and contingencies		601,600
Cost per million cubic feet of storage		1,086

Reservoir No. 2. (41).

Important Features.

Drainage area above dam	132 sq. mi.
Capacity of reservoir	1,511,400,000 cu. ft.
Height dam above stream	47 feet
Length of crest	595 "
Elevation of crest	1,877 "
Length of reservoir	8.5 miles
Average width	1,429 feet
Average depth	23.5 "
Area of surface	1,477 acres

Property Involved.

Land below flow line, 1,403 acres; marginal strip, 151 acres; total, 1,554 acres (98% wooded). The only development involved by this proposed project would be 6.2 miles of ordinary highway.

Estimate of Cost.

Dam		
Excavation	$ 6,900	
Concrete	109,300	
Riprap paving	2,900	
Gate house and appurtenances	23,200	
		$ 142,300
Land		9,900
Total		$ 152,200
Total, plus 15% for engineering and contingencies		175,000
Cost per million cubic feet of storage		115
Total flood control capacity of two projects		2,065,400,000 cu. ft.
Total cost of two projects		$ 776,600
Total maximum capacity of two projects		3,869,900,000 cu. ft.

ELK CREEK.

Elk Creek is a branch of the West Fork, which it enters at the town of Clarksburg, after flowing a distance of 29 miles from its source in Barbour County. The stream rises at an altitude of 1480 feet and passes through a comparatively thinly-settled but fairly well-cultivated valley, reaching the West Fork at an elevation of 925 feet. The Chestnut ridge anticlinal crosses the valley and extends southwestwardly over the West Fork, elevating the coal high above the stream. The basin has been largely deforested, only about 8 per cent of the area being now under forest cover.

The discharge at the mouth is estimated to reach a maximum of 7260 second-feet, or 60 second-feet per square mile, and a minimum of 3 second-feet, or 0.025 second-foot per square mile. The difference in level between extreme high and low water is about 10 feet.

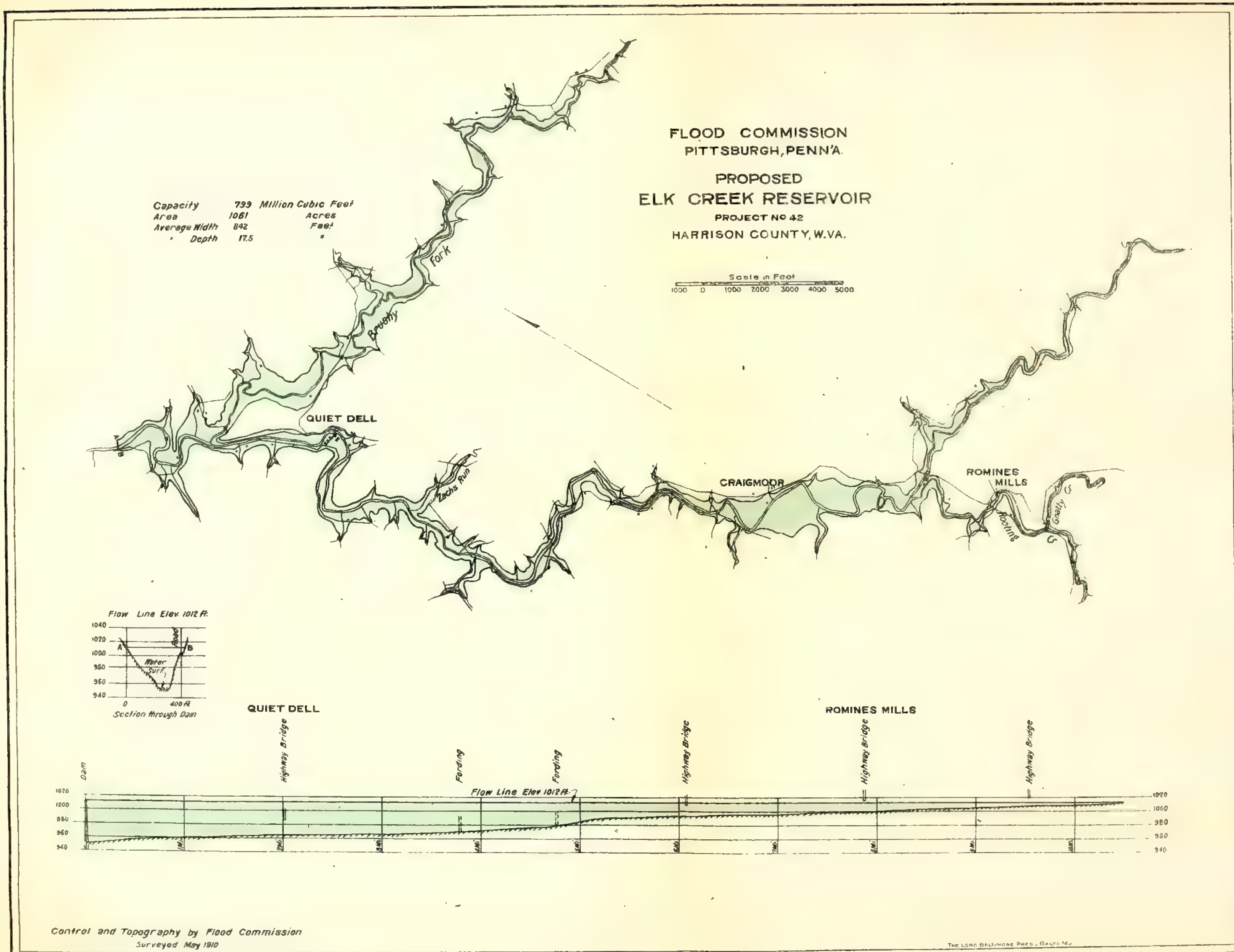
Reservoir Project. (42).

The site of the dam would have its location 6 miles from Clarksburg and 165 miles from Pittsburgh. A ledge of massive sandstone is at the site, and inspection of other parts of the locality indicated that rock could be reached for foundation purposes at moderate depth. An additional capacity of 458,300,000 cubic feet could be obtained by increasing the height of the dam to 66 feet.

Elk Creek, W. Va., November, 1910.
View down stream, showing crest of proposed dam.

Sandy Creek, W. Va., December, 1910.
View down stream, showing crest of proposed dam.


1020
1000
980
960
940
Contra


FLOOD COMMISSION
PITTSBURGH, PENN'A.
PROPOSED
ELK CREEK RESERVOIR
PROJECT No 42
HARRISON COUNTY, W.VA.
Scale in Feet
1000 0 1000 2000 3000 4000 5000
Capacity 799 Million Cubic Feet
Area 1061 Acres
Average Width 842 Feet
" Depth 17.5 "
Brushy Fork
QUIET DELL
Zachs Run
CRAIGMOOR
ROMINES MILLS
Rooting Cr.
Gnatty Cr.
Flow Line Elev. 1012 Ft.
Water Surf.
Road
Section through Dam
QUIET DELL
ROMINES MILLS
Dam
Highway Bridge
Fording
Fording
Highway Bridge
Highway Bridge
Highway Bridge
Flow Line Elev 1012 Ft.
Control and Topography by Flood Commission
Surveyed May 1910
The Lord Baltimore Press, Balto. Md.

Important Features.

Drainage area above dam	107 sq. mi.
Capacity of reservoir	799,100,000 cu. ft.
Height dam above stream	58 feet
Length of crest	425 "
Elevation of crest	1,012 "
Length of reservoir	10.4 mi.
Average width	842 feet
Average depth	17.5 "
Area of surface	1,061 acres

Property Involved.

Land below flow line, 985 acres; marginal strip, 207 acres; total, 1,192 acres (10% wooded).

Quiet Dell: dwellings, 8; barns, 3; schools, 1; stores, 2; grist mills, 1 (out of use); blacksmith shops, 1; cemeteries, 1; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 6; schools, 1; pump houses, 1; ordinary highway, 8.7 miles; highway bridges, 4.

Estimate of Cost.

Dam		
Excavation	$ 9,200	
Concrete	105,200	
Riprap paving	1,300	
Gate house and appurtenances	15,800	
		$ 131,500
Land		22,300
Buildings		19,000
Highways		36,000
Bridges		67,900
Total		$ 276,700
Total, plus 15% for engineering and contingencies		318,200
Cost per million cubic feet of storage		398

WEST FORK RIVER.

West Fork River has its source in the southwestern part of Upshur County, West Virginia, and flows a distance of 94 miles in a northerly and northeasterly course, joining the Tygart Valley River, with which it forms the Monongahela River, 1.4 miles south of the town of Fairmont.

This tributary of the Monongahela is fourth in size of drainage area and in length of stream. The drainage area, which has a greatest length of 62 miles, an average width of 14 miles and an area of 876 square miles, includes parts of Upshur, Lewis, Barbour, Harrison, Taylor and Marion counties. The general character of the country, in contrast to that of the basins to the east, is rolling, with numerous detached knobs, all considerably cultivated or cleared. The hills in the upper portion reach altitudes of about 1900 feet, and in the lower country, of about 1600 feet. The timber in the basin has been largely cut off, only about 15 per cent of the area remaining under forest cover.

From Weston to Clarksburg, 36 miles, the main valley and one of the larger branches have considerable bottom land, broad in places, through which the streams have a crooked course with a gradual and even flow. Between these two towns, the average fall per mile of the West Fork is 2.1 feet, and from this reach to the mouth, 31 miles, the fall is also 2.1 feet.

The maximum discharge of this stream at Enterprise, W. Va., 12 miles above the mouth, from a drainage area of 744 square miles, is 40,000 second-feet, or 53.8 second-

feet per square mile, and the minimum discharge during the drought of 1908 was 14 second-feet, or 0.019 second-foot per square mile. The maximum discharge occurred in July, 1888, a time when the streams are usually at fairly low stages. There is a difference of 32 feet between high and low water.

The Pittsburgh coal bed is in the valley from the mouth to above Weston, but above Clarksburg, according to available data, it is well back from the stream and high on the hills. A branch of the Baltimore & Ohio Railroad follows up the bank of the West Fork to Clarksburg, but south of that town to Weston it is out of the immediate valley. Beginning at the mouth of the river, the incorporated towns and their respective populations are: Monongah, 2080; Worthington, 290; Shinnston, 1220; Clarksburg, 9200; West Milford, 210; and Weston, 2210. At all the above towns below Clarksburg and at several others, mining operations of the Pittsburgh coal bed are actively carried on along the stream.

Reservoir Project. (43).

On account of the activities of coal mining and the location of railroad, no attempt was made to secure a site on the lower part of the stream. By the aid of the United States Geological Survey map and field examination, a site was selected 7.4 miles above Clarksburg, at a point where it is considered the dam will have rock footings at a depth of a few feet. The dam would be a distance of 38.4 miles from the mouth and 166.5 miles from Pittsburgh, and the reservoir, which is the longest of all the projects considered, would extend its backwater to Weston. Portions of two small villages, West Milford and Goodhope, would be involved under flow line, but could be moved to adjacent well-situated ground. Much of the bottom land is under cultivation or in pasture, and in the upper part of the reservoir section, a very considerable gas field of large output has been opened. It is said that this field will probably be largely exhausted in ten years or less. The outcrops of two coal beds, which are not mined, and are probably of uncertain quality, are under proposed flow line for a distance of five miles or more.

It is interesting to note that in the Report of the Chief of Engineers of the War Department for 1900, in discussing the feasibility of slackwater navigation on the West Fork, mention is made of the necessity of increasing the low-water flow by means of a storage reservoir above Clarksburg.*

Important Features.

Drainage area above dam	366 sq. mi.
Capacity of reservoir	2,724,300,000 cu. ft.
Height dam above stream	66 feet.
Length of crest	750 "
Elevation of crest	1,000 "
Length of reservoir	28.9 miles
Average width	990 feet
Average depth	18.0 "
Area of surface	3,455 acres

Property Involved.

Land below flow line, 3,008 acres; marginal strip, 694 acres; total, 3,702 acres (25% wooded).

West Milford: dwellings, 30; barns, 7; churches, 1; stores, 1; grist mills, 1; saw mills, 1; highway bridges, 1. Goodhope: dwellings, 14; barns, 3; churches, 1; cemeteries, 1; highway bridges, 1. In other parts of the valley are the following, which have been included in the estimate: dwellings, 15; barns, 18; schools, 1; saw mills, 1; pump stations, 1; boiler houses, 1; cemeteries, 1; oil wells, 2; gas wells, 12; ordinary highway, 14.6 miles; highway bridges, 1.

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*See Appendix No. 6.

West Fork River, W. Va., January, 1911.
View down stream, showing crest of proposed dam.

West Fork River, W. Va., January, 1911.
View of the village of West Milford.

WEST MILFORD
Lost Creek
Sycamore Creek
A
B
Flow Line Elev. 1000 ft.
Flood
Water Surface
0
400 ft.
800 ft.
Section through Dam.
WEST MILFC
Dam
Fording
Fording
Fording
Highway Bridge
1020
1000
980
960
940
920
Control and Topography by Flood Commission
Surveyed April 1910

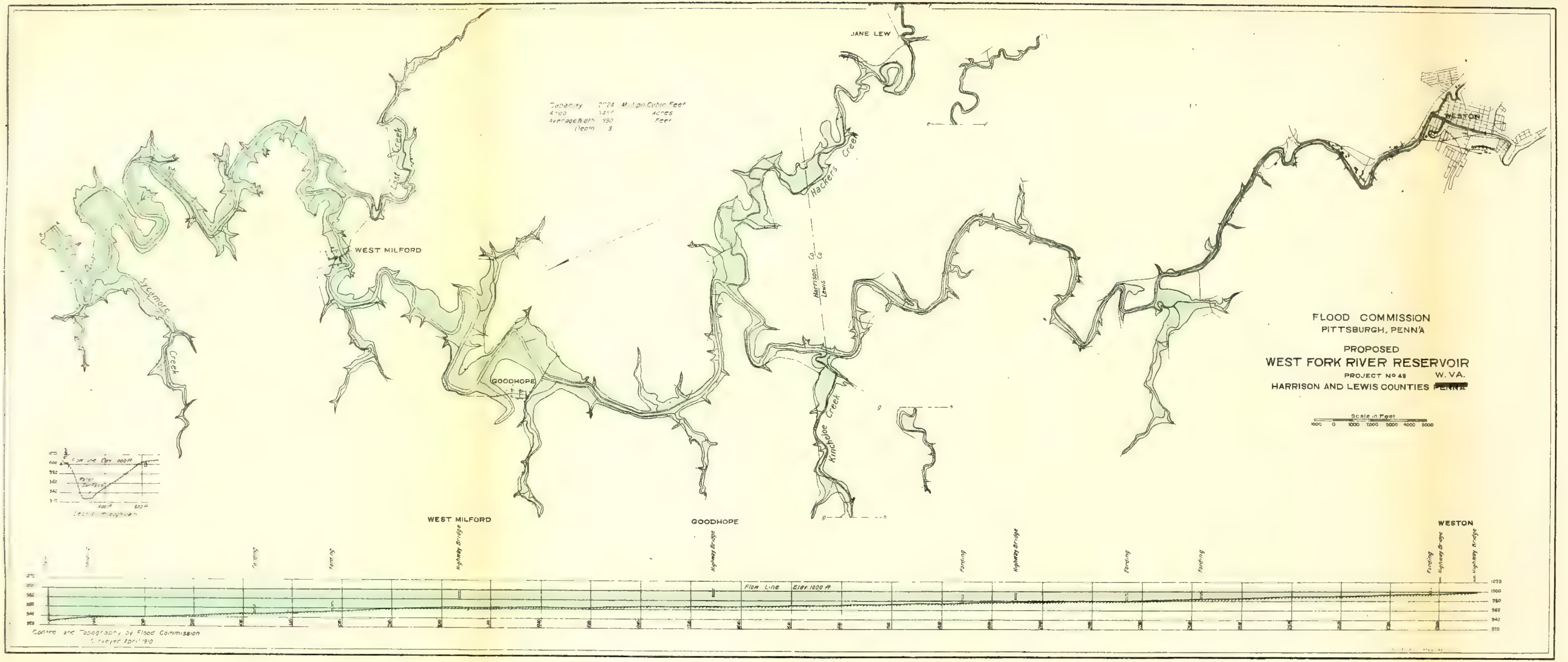

FLOOD COMMISSION
PITTSBURGH, PENN'A
PROPOSED
WEST FORK RIVER RESERVOIR
PROJECT No 42 W. VA.
HARRISON AND LEWIS COUNTIES
Scale in Feet
WEST MILFORD
GOODHOPE
JANE LEW
WESTON
Sycamore Creek
Lost Creek
Hackers Creek
Kincheloe Creek
Harrison Co
Lewis Co
Highway Bridge
Fording
Flow Line Elev 1000 ft
Control and Topography by Flood Commission

PLATE 51


WESTON
RVOIR
W. VA.
WESTON
Highway Bridge
Highway Bridge
1020
1000
980
960
940
920

Estimate of Cost.

Dam		
Excavation	$ 8,700	
Concrete	197,600	
Riprap paving	2,300	
Gate house and appurtenances	47,000	
		$ 255,600
Land and wells		129,600
Buildings		125,400
Highways		83,500
Bridges		111,300
Total		$ 705,400
Total, plus 15% for engineering and contingencies		811,200
Cost per million cubic feet of storage		298

TABLE No. 32.

IMPORTANT FEATURES OF RESERVOIR PROJECTS. MONONGAHELA BASIN.

Name	Number	Distance from dam to mouth	Drainage area above dam	Dam: Height above stream surface	Dam: Length of crest	Dam: Elevation of crest, Govt. datum	Reservoir: Length	Reservoir: Average width	Reservoir: Average depth	Reservoir: Area of surface	Reservoir: Capacity	Reservoir: Time required to empty	Reservoir: 6'x9' gates	Land area submerged: Total	Land area submerged: Wooded
		Miles	Sq. miles	Feet	Feet	Feet	Miles	Feet	Feet	Acres	Mill. cu. ft.	Days	No.	Acres	Per cent
Laurel Hill	22	5.2	114	125	1140	1510	3.4	1357	59.0	561	1438.4	2.6	3	503	78
Casselman No. 1	23	4.2	408	29	740	1399	1.1	583	19.5	77	66.3	0.3	3	50	68
Casselman No. 2	24	5.3	403	50	610	1440	1.8	472	22.5	101	99.6	0.3	3	72	90
Casselman No. 3	25	7.1	389	56	640	1495	2.0	488	27.0	120	141.0	0.4	3	85	96
Casselman No. 4	26	9.3	388	62	710	1562	1.5	603	25.0	109	119.8	0.4	3	83	85
Casselman No. 5	27	10.8	383	75	755	1625	2.4	502	31.0	143	192.9	0.4	3	100	85
Youghiogheny No. 1	28	71.1	431	44	635	1360	7.6	786	20.5	731	648.8	0.4	4	470	20
Youghiogheny No. 2	29	83.1	394	76	1270	1465	5.3	1452	38.0	940	1547.1	1.0	4	797	11
Youghiogheny No. 3	30	90.1	291	110	760	1650	2.1	839	52.5	227	519.8	0.4	4	184	95
Youghiogheny No. 4	31	95.6	272	98	625	2040	6.1	926	39.0	691	1170.4	0.9	3	536	50
Youghiogheny No. 5	32	104.6	160	55	410	2370	7.5	877	24.5	797	844.6	1.0	3	756	90
Cheat No. 1	33	3.5	1399	113	1040	900	15.5	1156	60.5	2175	5737.4	0.8	12	1461	57
Cheat No. 2	34	45.7	928	136	1130	1515	19.7	1237	56.5	2961	7294.1	1.4	12	2163	40
Shavers Fork No. 1	35	7.4	179	104	790	1870	3.5	713	41.0	306	549.0	0.7	4	253	30
Shavers Fork No. 2	36	14.8	159	100	760	2050	4.9	1393	46.5	838	1701.5	1.8	4	774	55
Sandy	37	2.1	85	116	805	1320	5.9	1131	25.5	797	883.4	2.4	2	739	49
Teters	38	1.2	49	91	770	1340	2.3	938	40.5	263	463.4	1.7	2	250	30
Buckhannon	39	8.2	273	45	420	1415	19.9	953	16.0	2540	1765.7	1.4	9	2130	93
Middle Fork No. 1	40	2.9	147	107	900	1795	3.2	777	41.5	307	554.0	0.8	3	292	97
Middle Fork No. 2	41	8.4	132	47	595	1877	8.5	1429	23.5	1477	1511.4	3.2	5	1403	98
Elk	42	6.0	107	58	425	1012	10.4	842	17.5	1061	799.1	1.5	3	985	10
West Fork	43	38.4	366	66	750	1000	28.9	990	18.0	3455	2724.3	1.6	11	3008	25
Total		....	*3379	...	...	....	....	...	....	20677	30772.0	...	..	17094	..
Average		....	...	80	700	....	7.4	929	34.0	939	1398.7	...	..	777	..

*Area controlled.

TABLE No. 33.

SUMMARY OF ESTIMATED COST OF RESERVOIR PROJECTS.

Reservoir project	Excavation	Concrete	Riprap paving	Gate house and appurtenances	Total dam	Land	Buildings	Highways	Bridges	Railroads	Total damages	Grand total	Grand total plus 15%
Buffalo	$ ----	$ ----	$ ---	$ ----	$ 350,000	$ 54,000	$ 10,000	$ 6,000	$ ----	$ ----	$ 70,000	$ 420,000	$ 483,000
Loyalhanna	25,400	711,900	14,900	31,500	783,700	114,200	27,900	18,600	68,200	50,000	278,900	1,062,600	1,222,000
Black Lick	17,400	358,100	5,400	41,800	422,700	53,100	64,300	25,900	48,600	11,900	203,800	626,500	720,500
Crooked	18,100	538,100	3,500	35,000	594,700	85,900	78,500	18,000	----	----	182,400	777,100	893,700
Mahoning No. 1	21,000	573,500	4,500	39,500	638,500	20,800	54,500	18,000	15,900	----	109,200	747,700	859,900
Mahoning No. 2	19,600	709,600	3,100	38,700	771,000	29,000	25,300	28,100	93,900	----	176,300	947,300	1,089,400
Little Sandy	17,000	388,800	2,000	13,500	421,300	29,400	48,000	13,100	----	----	90,500	511,800	588,600
North Branch Red Bank	----	----	---	----	405,000	13,500	----	15,400	----	----	28,900	433,900	499,000
Clarion No. 1	19,700	967,100	3,800	51,500	1,042,100	19,600	27,300	9,500	40,600	----	97,000	1,139,100	1,309,900
Clarion No. 3	12,800	608,300	3,200	41,000	665,300	40,900	96,100	12,200	79,500	----	228,700	894,000	1,028,100
Clarion No. 4	11,600	286,800	3,600	24,000	326,000	9,400	21,500	4,300	31,700	----	66,900	392,900	451,800
East Sandy No. 1	13,500	226,200	4,300	15,700	259,700	3,400	----	----	----	----	3,400	263,100	302,500
East Sandy No. 2	9,100	191,500	2,100	17,300	220,000	1,100	4,400	6,300	----	----	11,800	231,800	266,600
French	26,500	676,500	1,200	48,500	752,700	166,200	223,600	13,400	335,700	585,000	1,323,900	2,076,600	2,388,100
Cussewago	156,800*	234,800	42,800‡	24,000	458,400	49,800	10,300	4,200	49,300	----	113,600	572,000	657,800
North Branch French	17,000	367,400	5,100	32,700	422,200	54,700	103,700	15,600	32,300	----	206,300	628,500	722,800
Tionesta	11,700	447,600	2,700	47,700	509,700	29,000	101,500	17,500	323,200	204,000	675,200	1,184,900	1,362,600
Allegheny No. 1	19,900	325,300	12,000	45,500	402,700	52,100	46,000	----	----	560,000	658,100	1,060,800	1,219,900
Allegheny No. 2	32,300	704,700	21,400	48,500	806,900	118,300	952,800	----	180,300	600,000	1,851,400	2,658,300	3,057,000
Allegheny No. 3	26,000	485,600	18,000	48,400	578,000	76,100	61,100	----	----	490,000	627,200	1,205,200	1,386,000
Kinzua	23,700	453,300	3,100	25,500	505,600	18,300	144,700	47,700	5,000	168,000	383,700	889,300	1,022,700
Total, Allegheny	$499,100	$ 9,255,100	$156,700	$ 670,300	$11,336,200	$1,038,800	$2,101,500	$273,800	$1,304,200	$2,668,900	$7,387,200	$18,723,400	$21,531,900
Laurel Hill	$ 28,500	$ 817,800	$ 9,200	$ 20,300	$ 875,800	$ 10,800	$ 42,200	$ 10,600	$ 5,300	$ 99,000	$ 167,900	$ 1,043,700	$ 1,200,300
Casselman No. 1	8,000	95,500	600	15,700	119,800	900	1,600	----	----	----	2,500	122,300	140,700
Casselman No. 2	8,000	161,600	600	15,700	185,900	800	2,900	----	----	----	3,700	189,600	218,100
Casselman No. 3	9,100	182,700	700	15,700	208,200	800	3,200	1,100	13,900	----	19,000	227,200	261,300
Casselman No. 4	10,200	225,900	800	15,700	252,600	900	1,600	----	----	----	2,500	255,100	293,400
Casselman No. 5	12,400	318,400	900	15,800	347,500	1,100	2,800	----	----	----	3,900	351,400	404,100
Youghiogheny No. 1	13,700	183,300	1,500	19,500	218,000	17,400	12,600	----	----	225,000	255,000	473,000	543,900
Youghiogheny No. 2	32,400	555,400	10,300	21,000	619,100	23,800	16,100	----	----	210,000	249,900	869,000	999,300
Youghiogheny No. 3	13,700	450,800	3,200	19,500	487,200	7,200	8,400	----	----	20,000	35,600	522,800	601,200
Youghiogheny No. 4	10,300	237,200	2,100	18,000	267,600	11,300	13,900	----	----	40,000	65,200	332,800	382,700
Youghiogheny No. 5	4,600	86,600	1,400	16,500	109,100	9,800	----	----	----	----	9,800	118,900	136,700
Cheat No. 1	32,200	892,600	3,300	50,800	978,900	48,200	26,200	20,700	45,900	----	141,000	1,119,900	1,287,900
Cheat No. 2	34,500	1,152,400	7,000	53,700	1,247,600	36,900	61,500	46,900	104,400	----	249,700	1,497,300	1,721,900
Shavers Fork No. 1	25,100	539,700	4,600	25,500	594,900	4,800	15,500	----	----	----	20,300	615,200	707,500
Shavers Fork No. 2	15,600	491,800	3,700	24,000	535,100	11,100	13,200	----	----	----	24,300	559,400	643,300
Sandy	10,300	439,700	2,700	15,700	468,400	16,200	12,500	10,600	13,300	----	52,600	521,000	599,100
Teters	10,300	286,000	4,100	16,500	316,900	5,000	1,900	18,500	----	----	25,400	342,300	393,700
Buckhannon	5,800	98,100	1,200	39,500	144,600	19,600	2,500	5,300	----	----	27,400	172,000	197,800
Middle Fork No. 1	14,900	480,900	5,600	18,800	520,200	2,100	800	----	----	----	2,900	523,100	601,600
Middle Fork No. 2	6,900	109,300	2,900	23,200	142,300	9,900	----	----	----	----	9,900	152,200	175,000
Elk	9,200	105,200	1,300	15,800	131,500	22,300	19,000	36,000	67,900	----	145,200	276,700	318,200
West Fork	8,700	197,600	2,300	47,000	255,600	129,600	125,400	83,500	111,300	----	449,800	705,400	811,200
Total, Monongahela	$324,400	$ 8,108,500	$ 70,000	$ 523,900	$ 9,026,800	$ 390,500	$ 383,800	$233,200	$ 362 000	$ 594,000	$1,963,500	$10,990,300	$12,638,900
Grand total	$823,500	$17,363,600	$226,700	$1,194,200	$20,363,000	$1,429,300	$2,485,300	$507,000	$1,666,200	$3,262,900	$9,350,700	$29,713,700	$34,170,800

*Includes embankment for earthen dam.
‡Includes paving of earthen dam, broken stone lining and sheet piling.

TABLE No. 34.

FLOOD CONTROL CAPACITIES AND COST OF RESERVOIRS IN ALLEGHENY AND MONONGAHELA BASINS.

Project	Capacity (Cu. ft.)	Cost dam and appurtenances	Cost per mill. cu. ft. capacity	Total cost	Cost per mill. cu. ft. capacity
Allegheny Basin:—					
Buffalo	882,800,000	$ 350,000	$ 396	$ 483,000	$ 546
Loyalhanna	4,112,500,000	783,700	190	1,222,000	297
Black Lick	1,454,700,000	422,700	290	720,500	495
Crooked	3,255,700,000	594,700	183	893,700	274
Mahoning No. 1	1,421,700,000	638,600	449	859,900	605
Mahoning No. 2	2,367,800,000	771,000	326	1,089,400	460
Little Sandy	1,007,500,000	421,300	418	588,600	584
No. Br. Red Bank	1,350,000,000	405,000	300	499,000	369
Clarion No. 1	5,067,000,000	1,042,100	206	1,309,900	258
Clarion No. 3	4,886,600,000	665,300	136	1,028,100	210
Clarion No. 4	1,537,900,000	326,000	212	451,800	294
East Sandy No. 1	137,700,000	259,700	1885	302,500	2197
East Sandy No. 2	102,100,000	220,000	2155	266,600	2611
French	3,323,100,000	752,700	226	2,388,100	718
Cussewago	767,800,000	458,400	597	657,800	857
No. Br. French	2,125,700,000	422,200	198	722,800	340
Tionesta	3,629,600,000	509,700	140	1,362,600	376
Allegheny No. 1	2,876,300,000	402,700	140	1,219,900	425
Allegheny No. 2	4,877,900,000	806,900	165	3,057,000	626
Allegheny No. 3	2,663,600,000	578,000	217	1,386,000	520
Kinzua	1,877,800,000	505,600	269	1,022,700	544
Total	49,725,800,000	$11,336,200		$21,531,900	
Average	2,367,900,000	539,819	228	1,025,300	433
Monongahela Basin:—					
Laurel Hill	1,438,400,000	875,800	609	1,200,300	834
Casselman No. 1	66,300,000	119,800	1807	140,700	2122
Casselman No. 2	99,600,000	185,900	1867	218,100	2189
Casselman No. 3	141,000,000	208,200	1477	261,300	1853
Casselman No. 4	119,800,000	252,600	2109	293,400	2449
Casselman No. 5	192,900,000	347,500	1801	404,100	2095
Youghiogheny No. 1	648,800,000	218,000	336	543,900	838
Youghiogheny No. 2	1,547,100,000	619,100	400	999,300	646
Youghiogheny No. 3	519,800,000	487,200	937	601,200	1156
Youghiogheny No. 4	1,170,400,000	267,600	229	382,700	327
Youghiogheny No. 5	844,600,000	109,100	129	136,700	162
Cheat No. 1	5,737,400,000	978,900	171	1,287,900	224
Cheat No. 2	7,294,100,000	1,247,600	171	1,721,900	236
Shavers Fork No. 1	549,000,000	594,900	1084	707,500	1288
Shavers Fork No. 2	1,701,500,000	535,100	314	643,300	378
Sandy	883,400,000	468,400	530	599,100	678
Teters	463,400,000	316,900	684	393,700	841
Buckhannon	1,765,700,000	144,600	82	197,800	112
Middle Fork No. 1	554,000,000	520,200	939	601,600	1086
Middle Fork No. 2	1,511,400,000	142,300	94	175,000	115
Elk	799,100,000	131,500	165	318,200	398
West Fork	2,724,300,000	255,600	94	811,200	298
Total	30,772,000,000	$9,026,800		$12,638,900	
Average	1,398,700,000	410,309	293	574,500	411
Grand total	80,497,800,000	$20,363,000		$34,170,800	
General average	1,872,000,000	473,558	253	794,699	424

STREAMS UPON WHICH STORAGE HAS NOT BEEN CONSIDERED.

The following pages treat of streams upon which reservoir storage has not been considered, either because of unfavorable topography or developments along their valleys. Further and more extensive investigations, however, might show that some of these streams could be economically and effectively used, but such extensive and costly investigations do not seem warranted at this time, for the purposes of the report.

ALLEGHENY BASIN.

KISKIMINETAS RIVER.

The Kiskiminetas River is not only the most important tributary, commercially, of the Allegheny, but the largest in drainage area, which covers 1877 square miles, or about 16 per cent of the Allegheny Basin. The stream, from the city of Johnstown to the town of Saltsburg, has the name of Conemaugh River, and is formed by the Little Conemaugh River and Stony Creek, which come together at Johnstown, after the former stream has flowed westwardly 26 miles from its source on the Allegheny Mountain. The Conemaugh has a length of 53 miles and in its northwesterly course receives Black Lick Creek, on the right bank, at the town of Blairsville, and Loyalhanna Creek, on the left bank, at Saltsburg. The Kiskiminetas flows due northwest, 26 miles, is entered by Beaver Run on the left bank, at the village of Paulton and joins with the Allegheny River 30.2 miles above Pittsburgh.

Stony Creek, which has a length of 34 miles, with its Shade and Quemahoning branches, really forms the headwaters of the Kiskiminetas, and by this creek the total stream length to the Allegheny is 113 miles. From a point seven miles below the source of Stony Creek, the average fall of the stream per mile is about 13.8 feet; and by long reaches from this point, the fall per mile is as follows: to Quemahoning Creek, 12 miles, 55.5 feet; thence to Johnstown, 15 miles, 24.7 feet; thence along the Conemaugh to Black Lick Creek, 38 miles, 7 feet; thence to Loyalhanna Creek, 15 miles, 4.4 feet; thence to the mouth, 26 miles, 3.5 feet. The elevation of the water at Johnstown is 1160 feet, at Black Lick Creek 894 feet and at the mouth 737 feet.

Since June, 1907, when the records at this station began, the Kiskiminetas River at Avonmore, 21.5 miles above the mouth, has discharged from a drainage area of 1720 square miles, a maximum of 67,250 second-feet, or 39.1 second-feet per square mile, and a minimum of 65 second-feet, or 0.038 second-foot per square mile. The discharge in the flood of March, 1907, reached a maximum of 76,600 second-feet, or 44.5 second-feet per square mile. The record stage at Avonmore occurred in 1859, when the discharge reached 80,000 second-feet, or 46.5 second-feet per square mile. The variation between high and low water stages is about 32 feet.

The territory drained includes portions of Cambria, Somerset, Indiana, Westmoreland and Armstrong counties, and the tributaries flow through valleys which, in many places, are steep-sided and rugged. While the valleys are largely deforested on the lower slopes, about 37 per cent of the basin is in woodland, mostly along the crests of three ridges, namely: Chestnut ridge, which crosses northeastwardly, practically ending as a well-defined ridge, just east of Blairsville; Laurel ridge, paralleling the above mentioned ridge, with elevations reaching 2700 feet, crossing about four miles west of Johnstown; and lastly, the Allegheny Mountain, reaching elevations of nearly 3000 feet and forming the watershed above the head branches.

In the gorges, where the stream cuts deeply through the Chestnut and Laurel ridges, the scenery is notably fine. This is also the case at a number of other points

along the Pennsylvania Railroad, which follows the stream to the top of the Alleghenies.

The coals of the Allegheny measures underlie nearly the whole basin, probably the only place where they are conspicuously absent being along the Laurel ridge anticlinal. At Blairsville, and midway to Saltsburg, and also at a point a short distance below that place, synclinals bring into the valley the overlying Pittsburgh coal bed, which projects northwardly, from the main mass, in three long, narrow fields. Mines are scattered along the main valley of the stream below Johnstown and a greater number seem to be on each of the two tributaries above that city. Massive sandstone exposures appear here and there, noticeably at the mouth of the Loyalhanna.

The Western Pennsylvania Division of the Pennsylvania Railroad follows the stream from the mouth to Blairsville Intersection, three miles east of Blairsville. At the Intersection, the valley is entered, from Pittsburgh, by the main line of the Pennsylvania Railroad, which has four tracks paralleling the stream to Johnstown and continuing eastwardly up the Little Conemaugh to the Gallitzin tunnel, on top of the Allegheny Mountain, 2150 feet above tide. The Baltimore & Ohio Railroad has a branch line extending from Rockwood, on the Pittsburgh division, into Stony Creek valley, and down that stream to Johnstown.

The principal towns located along the main stream and their respective populations are: Johnstown, 55,480; New Florence, 720; Bolivar, 520; Blairsville, 3570; Livermore, 120; Saltsburg, 1040; Avonmore, 1260; Apollo, 3010; Vandergrift, 3880; Leechburg, 3620.

The physical conditions obtaining on the Kiskiminetas, together with the heavy precipitation and run-off and the proximity of the stream to Pittsburgh, caused careful attention to reservoir possibilities within its watershed. The basin is particularly fan-shaped, with numerous tributaries flowing from a considerable area of steep-sloped country, which frequently cause rapid collection of flood run-off in the Saltsburg vicinity and down the short trunk of the river to the Allegheny. Railroad, town and mining developments have interfered with plans for projects on the main stream and on the tributaries excepting Black Lick and Loyalhanna Creeks.

Shade Creek, a branch of Stony Creek entering on the right bank, with a catchment area of 95 square miles, was examined, but abandoned on account of the steep stream grade and the presence of one or two coal beds. The valley, from a short distance above its mouth, is rough, largely wooded and undeveloped, and some time in the future it might seem advisable to include it in the reservoir system.

Quemahoning Creek, with a basin area of 109 square miles, received on the left bank of Stony Creek, above the mouth of Shade Creek, was investigated, but also abandoned; partly for the reason that a reservoir is now being built in the valley a few miles above the mouth, for industrial supply in Johnstown. The main features of this reservoir are as follows: Drainage area, 92 square miles; capacity, 1,450,000,000 cubic feet; height of dam (earthen), 90 feet; length of crest, 1100 feet; length of pool, about 3 miles. In this valley there is considerable cultivated land and one or two beds of coal, which are mined on the upper reaches.

On Beaver Run, close to its junction with the Kiskiminetas, there is a reservoir built by a company for supply in the borough of Apollo. For this reason the stream was not examined, as the area of the basin is small.

COWANSHANNOCK CREEK.

Cowanshannock Creek has its source just within the limits of the northwestern

part of Indiana County and flows westwardly 23 miles, through Indiana and Armstrong counties, joining the Allegheny River on the left bank, 3.5 miles above Kittanning, and 49.1 miles above Pittsburgh. The elevation of the source is about 1410 feet and of the mouth 773 feet. The drainage basin, of which 24 per cent is wooded, has an area of 63 square miles. The higher hilltops of the surrounding divide reach elevations ranging from 1300 to 1400 feet on the north and south, and 1600 feet at the source.

The topography is favorable for a reservoir large enough to control the floods of this creek, but as the basin is small and as coal of the Allegheny River formation, of fair quality, abounds along the valley, a reservoir project on this stream has not been thought of sufficient importance for consideration at this time.

BIG PINE CREEK.

Big Pine Creek lies entirely in Armstrong County, about five miles south of Mahoning Creek. The stream rises at an elevation of 1360 feet, and after flowing a distance of 16 miles, enters the Allegheny River on the left bank, at an elevation of 777 feet, 51.2 miles above Pittsburgh. The drainage basin has an area of 52 square miles, of which about 25 per cent is wooded. Coal, of the Allegheny River series, is in the hills of the valley, but is not mined to any extent.

A reservoir project has not been considered on this valley, but the topography would permit one of comparatively small size on the lower reach, without interference with the track of the Buffalo, Rochester & Pittsburgh Railroad, which follows the entire length of the stream.

RED BANK CREEK.

Red Bank Creek, by its main tributary, Sandy Lick Creek, rises in the northwestern part of Clearfield County and flows southwestwardly a distance of 79 miles, joining the Allegheny River, on the left bank, at an elevation of 807 feet, at Red Bank Junction, 64.9 miles from Pittsburgh. Two branches are received on the right bank at Brookville, one of them being the North Branch, which has been included in the system of reservoir control, as is also the case with Little Sandy Creek, another important branch entering on the left bank four miles above New Bethlehem.

The basin has an area of 585 square miles, a greatest length of 50 miles and an average width of 11.7 miles, and drains portions of Clearfield, Jefferson, Clarion and Armstrong counties. The lower portion of the stream forms the boundary line between the last two counties and along this stretch the divides reach elevations of 1500 to 1600 feet above sea, the south ridge being quite close to the stream. Much of the lower stream is in a narrow and steep-sided valley, but on the upper reaches considerable flat land obtains. About 38 per cent of the basin, principally around the headwaters, is wooded.

The average fall of the entire stream is about 11.4 feet per mile, and the length and fall by long reaches from the source to the mouth are approximately as follows: To Falls Creek, 13 miles, 25.3 feet; thence to Brookville, 23 miles, 7.6 feet; thence to mouth of Little Sandy Creek, 17 miles, 7.1 feet; thence to New Bethlehem, 4 miles, 9.3 feet; thence to St. Charles, 8 miles, 6.3 feet; thence to mouth, 14.0 miles, 13.7 feet.

The discharge at the mouth varies between a maximum of 27,000 second-feet, or 46.2 second-feet per square mile, and a minimum of 11 second-feet, or 0.019 second-foot per square mile. There is a difference of about 14 feet between high and low water.

An important branch of the Pennsylvania Railroad system closely follows the

main stream and the Sandy Lick tributary from Red Bank Junction, on the Allegheny River, to Driftwood, which is on a tributary of the Susquehanna River.

The important towns located on Sandy Lick Creek and their respective populations are: Dubois, 12,620; Falls Creek, 1200; Reynoldsville, 3190; and on the main stream: Brookville, 3000; Summerville, 610; New Bethlehem, 1630.

Practically the whole drainage basin holds coal of the Allegheny measures, which is considerably mined. A number of mines are located along the main stream below Little Sandy Creek, where the coal appears to be high above water.

The topography of this stream is well formed for large storage, but on account of the developments, no attempt was made for control; although, should the future show this to be desirable, it might be possible, by adjustment of the railroad grades on the lower reaches, to secure results that would be effective and not too costly.

BEAR CREEK.

Bear Creek rises in the northeastern part of Butler County and flows 13 miles northeastwardly, entering the Allegheny River on the right bank in Armstrong County. The elevation of the source is about 1330 feet and the river is joined just below the town of Parker at an elevation of 841 feet, 83.9 miles above Pittsburgh. The drainage basin, of which 33 per cent is wooded, has a greatest length of 14 miles, an average width of 4.4 miles, and an area of 61 square miles. The higher hills of the watershed attain elevations of from 1400 to 1500 feet. This stream is not considered to present storage possibilities on an adequate scale unless the Foxburg branch of the Baltimore & Ohio Railroad, which parallels the left bank, is raised to a higher level. The expense of doing this cannot be advised at this time.

SANDY CREEK.

Sandy Creek, from its source in the southwestern part of Crawford County, flows southeastwardly through the northeastern part of Mercer County and enters Venango County, joining the Allegheny River on the right bank, 10 miles south of Franklin and 116.6 miles above Pittsburgh. The elevation of the source is about 1330 feet and of the mouth, 928 feet.

The drainage basin, which has a length of 28 miles, an average width of 5.4 miles and an area of 152 square miles, is wide at the mouth and unusually narrow at the source. Some of the higher hills of the lower half of the shed reach elevations of from 1500 to 1600 feet. About 36 per cent of the basin is wooded.

The line of the terminal moraine crosses about seven miles from the stream mouth and all of the basin above this line has been involved by glacial action. Sandy Lake, which is used as a summer resort and is situated in the eastern part of Mercer County, on a short branch at an elevation of about 1165 feet, is undoubtedly of glacial origin. The immediate valley of the creek lies below the red shale for a distance of nearly eight miles above the mouth.

The lower six mile reach of the valley is very favorable, topographically, for a reservoir of considerable size and of reasonably short dam, but an important railroad, a branch of the Lake Shore & Michigan Southern, has recently been built close along the stream, and it is thought that the damages resulting from construction of a project on this stream would not be warranted.

CONNEAUT LAKE CREEK.

Conneaut Lake Creek, in the southern part of Crawford County, drains Conneaut Lake, from the outlet of which it flows southeastwardly a distance of 12 miles, and

joins French Creek on the right bank about 7 miles south of the city of Meadville. The lake has a length of 2.6 miles, an elevation of 1072 feet, and lies in a glacial country, surrounded for most part by broad, flat hills. The stream, flowing from the southern end of the lake, passes through a marshy valley, which, in the upper portion, is about a mile wide. It is known that the glacial deposit attains considerable depth in a number of places in the basin and that this condition extends westwardly, across the low divide, into the Pymatuning Swamp country, at the head of the Shenango River. This swamp has an elevation of about 1010 feet.

The basin has an area of 95 square miles, of which 21 per cent is wooded. About five miles below the lake the valley is crossed by the Erie Railroad on a low grade. This stream, on account of the conditions prevailing, has not received any serious consideration for a reservoir project.

OIL CREEK.

Oil Creek rises by its East Branch in the extreme southwestern corner of Erie County, Pennsylvania, and flows southwardly through the eastern part of Crawford County, joining the Allegheny River 134.2 miles above Pittsburgh, at Oil City, in the central part of Venango County. The total length of the stream is 39 miles and in the lower 15 miles, from Titusville to the mouth, it falls at the rate of about 13 feet per mile, to an elevation of 982 feet.

The drainage basin, which has an area of 303 square miles, covers portions of Erie, Crawford, Warren and Venango counties. A small lake is situated on the West Branch, which enters the East Branch 10 miles below its source, and several miles above the line of the terminal moraine. About 42 per cent of the basin is wooded.

The discharge at the mouth varies between a maximum of 15,000 second-feet, or 49.5 second-feet per square mile and a minimum of 39 second-feet, or 0.13 second-foot per square mile. There is a difference of about 10 feet between high water and low water.

The entire main stream and practically all the branches have cut below the Mauch Chunk Red Shale and into the Catskill Sandstone. The Allegheny River coal measures are in the upland country, but end about at the crossing of the terminal moraine. One of the largest and most productive oil fields ever found in the Allegheny Basin was commercially opened in this region in the year 1857, but large developments did not follow until some years later. While the field is still productive, many of the wells have become exhausted and others greatly reduced in output.

The principal towns along the main stream and their respective populations are: Centerville, 260; Titusville, 8540; Rouseville, 650. Titusville is situated 15 miles above the mouth, and northwardly from this city the basin widens out into a fan shape. An important line of the Buffalo & Allegheny Valley Division of the Pennsylvania System is closely located along the stream and upon frequently occurring bottom land, on the lower reaches.

It is thought that reservoiring on an adequate scale for control of this stream would have to be accomplished below Titusville, but the conditions obtaining did not seem favorable enough to warrant the expense of special surveys, which would have been necessary in this district.

HICKORY CREEK.

Hickory Creek, from its source in the southern part of Warren County, flows a distance of 13 miles in a southwesterly direction, and joins the Allegheny River on the

left bank, in the northwestern part of Forest County, 161.6 miles above Pittsburgh. The elevation at the mouth is 1069 feet.

Notwithstanding that lumber manufacture is active on this stream, the percentage of standing timber, according to the Forest Service investigation, is considerably higher than on any of the other basins, over 98 per cent of the area being wooded. Several mills of large output are located on the stream about a mile above its mouth at the village of Endeavor, and a lumber railroad, which crosses the divide from the Tionesta valley, extends down Beaver Creek Branch and connects the mills with the main line of the Pennsylvania Railroad at the town of Hickory.

To impound water from the Beaver Branch, as well as from the main stream, a dam would be so located that valuable property of the lumber interests at the village of Endeavor would be involved, including a portion of the small railroad. Considering these features and the small size of the stream, a project is not recommended at this time.

BROKENSTRAW CREEK.

Brokenstraw Creek rises in the southwestern part of Chautauqua County, New York, and after flowing a distance of 10 miles in a southerly course, enters the State of Pennsylvania, and empties into the Allegheny River, on the right bank, at the town of Irvineton, in the central part of Warren County, 184 miles from Pittsburgh. The stream falls at the average rate of 14.4 feet per mile, from an elevation of 1710 feet at the source, to 1149 feet at the mouth. From the state line to the mouth, 29 miles, the fall per mile averages 9.7 feet.

The drainage basin has an area of 319 square miles, of which about 46 per cent is wooded, covering mostly the lower portion of the area to the south of the terminal moraine. Along the southern side of the stream, a considerable amount of the woodland has been damaged by fire. The hills at the source of the stream, where the higher elevations reach 1860 feet, form a portion of the upper French Creek divide, and the southwestern edge of the Lake Chautauqua Basin.

The discharge at the mouth varies between a maximum of 14,350 second-feet, or 45 second-feet per square mile and a minimum of 45 second-feet, or 0.14 second-foot per square mile. There is a difference of about 12 feet between high and low water.

The immediate valley of the stream is notably wide and flat for practically 20 miles above the mouth. A reservoir project of any considerable size is considered unfeasible, not only on account of these topographical conditions, but because excessive damages would result from overflow, as an important railroad, the Philadelphia & Erie, is located on the low ground, passing through a fine farming country and connecting a number of attractive towns.

Little Brokenstraw Creek is received by the main stream at the village of Pittsfield, 8 miles from the Allegheny River, and judging from an examination made under heavy snow conditions, a small project upon this stream is thought to be feasible. The natural location for the dam would be in a narrow part of the valley, about 2 miles from the mouth. About 75 square miles of drainage would be tributary to this site, but surveys were not made and the project was abandoned.

CONEWANGO CREEK.

Next to French Creek, Conewango Creek is the largest tributary entering the Allegheny on the right bank. From an elevation of about 1640 feet at its source, in the northeastern part of Chautauqua County, New York, it flows almost due south a dis-

tance of 74 miles, and enters the Allegheny 192 miles above Pittsburgh, at the town of Warren, Pa., where the elevation is 1174 feet.

The general topography and the drainage system form an interesting study. The basin, which has an area of 892 square miles, is quite wide at the upper end, where the divide runs closer to Lake Erie than any other part of the great Ohio Basin, at one point, northwest of Lake Chautauqua, being less than four miles distant. The elevation of Lake Erie is 573 feet, Lake Chautauqua, 1308 feet, while the divide between has an elevation of about 1400 feet, rising at several points in the northeast and along the Conewango-Allegheny divide to 2100 feet. The general country consists of shale formation and for the greater part, wide, gradual slopes obtain, indicating glacial action. Near the head of a number of the upper branches, glacial lakes and swamps are of frequent occurrence. The terminal moraine crosses the basin near the lower end, and therefore practically the entire area is involved by the glaciated field. About 24 per cent of the basin is wooded.

Lake Chautauqua, by far the largest of the lakes, famous as a summer resort, lies in the southwestern part of New York State and from its southern end, at the city of Jamestown, a short, winding stream flows southwestwardly, connecting with Cassadaga Creek, which in turn drains into the Conewango, 25 miles north of Warren. It is notable that a number of lakes and swamps have nearly the same elevation. About 12 miles to the northeast of Lake Chautauqua, the Upper and Lower Lakes have elevations of 1306 feet, or only two feet lower than Lake Chautauqua, while 14 miles to the east of these, a swamp, 10 miles long and nearly a mile wide, through which Conewango Creek flows, has an elevation of about 1300 feet.

For the upper nine miles of the stream, to near the head of the large swamp, the rate of fall per mile is 35.6 feet, while through the swamp, where the stream has a multitude of small turns, and on down to Cassadaga Creek, a distance of 40 miles, the rate of fall is two feet. From here to the mouth, for 25 miles, the rate is 2.6 feet.

Since October, 1909, the maximum discharge at Frewsburg, N. Y., located 21 miles above the mouth and draining an area of 550 square miles, has been 11,500 second-feet, or 20.9 second-feet per square mile, and the minimum, 200 second-feet, or 0.36 second-foot per square mile. The maximum discharge at Frewsburg is estimated to reach 22,000 second-feet, or 40 second-feet per square mile, and the minimum to fall as low as 90 second-feet, or, 0.164 second-foot per square mile. There is a variation of about 15 feet between high and low-water stages.

The valley narrows considerably along the lower 13 miles and near the upper end of this reach a dam of considerable impounding capacity seems feasible; but the spread of the water on the flats above, even with a low dam, would involve a railroad of the New York Central system, a trolley road, a portion of the village of Frewsburg, a number of miles of highway and much land, some of which is under a fair state of cultivation. A general examination of the lower valley and a study of the U. S. Geological Survey maps resulted in the conclusion that conditions did not warrant the expense of making surveys on this stream or encouraging serious consideration at this time of a reservoir project.

ALLEGHENY RIVER AND PRINCIPAL TRIBUTARIES ABOVE KINZUA CREEK.

The Allegheny River, above the mouth of Kinzua Creek, flows at frequent intervals through long, low stretches of wide bottom land, a considerable part of which is in a fair state of cultivation. There are certain stretches, however, where the hills,

which are generally steep-sided, close in near to the stream. According to railroad levels, the elevation of the stream about one mile below the source in Potter County, Pa., is 2210 feet above sea; and from this point the length and fall by long reaches are as follows: To Colesburg, 4.9 miles, 77.6 feet; thence to Coudersport, 6.8 miles, 27.9 feet; thence to Port Allegany, 16.5 miles, 10.7 feet; thence to mouth of Oswayo Creek, 24 miles, 1.4 feet; thence to Olean Creek (Olean), 6.2 miles, 1.6 feet; thence to Great Valley Creek, 20.7 miles, 2.3 feet; thence to Kinzua Creek, 31.8 miles, 5.1 feet.

The prevailing rocks of this whole upper region consist of shale and sandstone and are much the same as obtain for a considerable distance below Kinzua. The terminal moraine lies about 8 miles to the north of the river at Kinzua, and, following upstream, gradually becomes closer until it crosses the river, a few miles west of Olean, and recrosses to the north just east of that city.

The important towns located on the stream and their respective populations are: Coudersport, 3100; Olean, 14,740; Salamanca, 5790; Warren, 11,080. Indian reservations maintained by the National Government occupy a considerable belt of the valley, on each side of the stream, beginning at a point about 10 miles below the New York state line and extending into that state to a point about ten miles above Salamanca. The Buffalo & Allegheny Valley Division of the Pennsylvania Railroad follows the flats, in places close to the water, all the way up the stream to Port Allegany, where it ascends a small tributary in the direction of the town of Emporium, which is located on a branch of the Súsquehanna River. From Port Allegany, the Coudersport & Port Allegany Railroad follows the stream to near the head and then passes over the divide into the Genesee River valley.

The discharge of the Allegheny River at Red House, New York, 12 miles above the Pennsylvania state line and 226 miles above the mouth, from a drainage area of 1640 square miles, varies between a minimum of 100 second-feet, or 0.06 second-foot per square mile, and a maximum of 41,000 second-feet, or 25 second-feet per square mile. The above maximum discharge is the greatest during the term of the record, since September, 1903, but it is probable that the maximum reaches about 49,000 second-feet, or 30 second-feet per square mile. There is a variation of about 11 feet between high water and low water at Red House.

Potato Creek. This stream, which has a basin area of 225 square miles, entirely in Pennsylvania, flows a distance of 25 miles nearly due north from the southeastern part of McKean County, and enters the Allegheny River on the left bank, at an elevation of 1451 feet, 23 miles above the city of Olean, and 277 miles from Pittsburgh. About 75 per cent of the drainage area is wooded. The valley is for the most part wide and the bottom land cultivated or used for grazing purposes. On the lower reach is the Kushequa Railroad, and from the mouth nearly to the head is a branch of the Buffalo & Allegheny Valley Division of the Pennsylvania Railroad.

Oswayo Creek. The basin of this stream lies in Pennsylvania and New York, the greater part of the drainage area of 246 square miles being in the former state. The creek rises in the northwestern part of Potter County, has a northwesterly course, and after flowing a distance of 23 miles, enters the state of New York, joining the Allegheny 3.8 miles further, on the right bank, at an elevation of 1430 feet, 7 miles above Olean and 261 miles from Pittsburgh. The total wooded area covers nearly 65 per cent of the basin. The low, wide flats on the lower reaches are swampy close to the stream, which condition also obtains on the Allegheny above the mouth of the creek. The higher portions of the low land are cultivated and upon these are located the Pitts-

burgh, Shawmut & Northern Railroad, and the traction road of the Western New York & Pennsylvania Company.

Olean Creek. This stream drains a basin of 201 square miles, wholly in New York State, and flows southwardly 32 miles from the northeastern part of Cattaraugus County, entering the Allegheny on the right bank, at Olean, at an elevation of 1420 feet, 254.5 miles from Pittsburgh. From below the village of Hinsdale, 8.5 miles above the mouth, the fall per mile is 3.3 feet, and along this part of the stream the bottom land of the valley is uniformly wide and flat with two lines of railroad following closely along the well-defined foot of the hill on each side. For a distance of several miles above the mouth, nearly one hundred oil tanks are scattered over the flats. The greater part of the immediate valley appears to be in a very good state of cultivation. About 25 per cent of the basin is wooded.

Great Valley Creek. This stream nearly parallels Olean Creek, on the west, entering the Allegheny on the right bank at the town of Salamanca, at an elevation of 1372 feet and a distance of 234 miles from Pittsburgh. The drainage basin has an area of 137 square miles, of which 32 per cent is wooded, and a length of 23 miles, the lower reaches of which are bordered by bottom land of considerable width, through which runs the Buffalo, Rochester & Pittsburgh Railroad.

Tuneungwant Creek. From the Kinzua divide, in McKean County, Pennsylvania, this stream flows northwardly, joining the Allegheny River at an elevation of 1388 feet on the left bank at Riverside Junction, Cattaraugus County, New York, 240 miles from Pittsburgh. The stream has a length of 25 miles and drains an area of 160 square miles, of which about 78 per cent is wooded. While the lower portion of the stream consists of many short bends, the general valley is unusually straight and comparatively wide, with two lines of railroad on the bottom land to the right, one of them being the Buffalo, Rochester & Pittsburgh, and the other, a branch of the Erie Railroad, extending southward from Salamanca.

It is believed that the conditions now existing on the Allegheny and its principal tributaries, above Kinzua Creek, do not offer favorable opportunities for economic reservoir construction.

A series of low dams might be built below Red House, but it is questionable as to whether the results gained would warrant the cost of disturbance to property caused by the overflow. Above Red House, 6.5 miles below Salamanca, it is thought that reservoir projects can never be attempted on account of the great amount of wide lowland on the main stream and on the lower reaches of all the principal tributaries. A number of towns and much railroad property, steam and electric, would have to be removed a considerable distance from their present locations.

MONONGAHELA BASIN.

TURTLE CREEK.

Turtle Creek rises in the western part of Westmoreland County and flows westwardly 18 miles, entering the Monongahela River on the right bank at Port Perry, 11.7 miles above the mouth, at Pittsburgh. This is the first stream of any consequence entering the Monongahela above Pittsburgh. From the source, elevation 1160 feet, the stream falls in a distance of 12 miles to an elevation of 762 feet, at the junction with Brush Creek, at Trafford City, and thence in a distance of 6 miles, to an elevation of 715 feet at the mouth, which is in pool No. 2 of the Monongahela River. Brush Creek, which has a length of 19.5 miles, rises about four miles north of Greensburg, near

Hannastown, at an elevation of 1280 feet. On the opposite side of the divide, at the headwaters of this stream, Beaver Run, a tributary of the Kiskiminetas, has its source.

The drainage basin has an area of 145 square miles, of which only about 11 per cent is wooded. The discharge at East Pittsburg, near the mouth, varies between a maximum of 9375 second-feet, or 64.5 second-feet per square mile, and 10 second-feet, or 0.10 second-foot per square mile, part of which is probably mine water.

On Brush Creek, between Penn Station and Larimer, a distance of 6.6 miles, the stream is crossed by a belt of Pittsburgh coal, which is considerably mined. Penn Station is 12.8 miles above the mouth at Trafford City. Below Larimer the ground holds the Allegheny coal measures.

Turtle Creek, from the mouth to Trafford City, is much congested by railroad and manufacturing developments, while above this point the main line of the Pennsylvania Railroad parallels Brush Creek for nearly its entire length, and a branch of the same railroad ascends Turtle Creek. These conditions would prevent an effective flood control reservoir from being built on this stream.

BIG SEWICKLEY CREEK.

Big Sewickley Creek, in Westmoreland County, also called Sewickley Creek, rises on the western slope of the Chestnut ridge, flows 30 miles nearly due west and joins the Youghiogheny River, on the right bank, 17 miles above the mouth of that stream. The elevation at the mouth is 738 feet. Beginning at a point 18 miles above the mouth, the stream falls at the rate of 5.5 feet per mile, for 11 miles, and at the rate of 20.3 feet per mile for the remaining 7 miles. The drainage area, 158 square miles, includes the city of Greensburg, which is situated in the northeastern part.

A division of the Pennsylvania Railroad, operating between Greensburg and Connellsville, follows a portion of the upper part of the valley, leaving the stream at Hunkers, in going southward. From Hunkers a branch has recently been extended for most of the distance down to the mouth.

Topographically the valley is well formed for storage, but in view of railroad and Pittsburgh coal developments, made and proposed, on the lower reaches, and the presence of other coals along this part of the stream, the consideration of reservoir projects cannot be recommended at this time.

JACOBS CREEK.

Jacobs Creek has its source on the western slope of Chestnut ridge, almost exactly opposite the headwaters of Loyalhanna Creek, which flows northwardly into the Kiskiminetas River from the eastern slope of this ridge. The stream flows in a general westerly direction for a total length of about 31 miles, and empties into the Youghiogheny River on the right bank, 27 miles from the Monongahela River, at an elevation of 770 feet. From Scottdale to a point 7 miles below, the fall per mile is 2.9 feet and for the remainder of the way, 7 miles, the fall per mile is 31.6 feet. For a considerable portion of its length from the mouth eastwardly, this creek forms the boundary line between Westmoreland and Fayette counties.

The drainage area is 101 square miles, of which 26 per cent is wooded. U. S. Geological Survey maps, covering most of the basin below the Chestnut ridge, show the higher elevations of the watershed to range from 1300 to 1400 feet.

The stream, from a point about two miles below Scottdale, flows through a comparatively narrow and thinly-settled valley along which part are to be found only the coals of the Allegheny series, which are as yet only slightly mined. The eastern edge

of the main field of the Pittsburgh bed crosses about at the mouth of the stream, in a northeasterly and southwesterly direction. Scottdale is located in the long, narrow belt of the famous coking coal, and in this region the stream has received large mining developments which are connected by through lines of railroad.

So far as the topography is concerned, a reservoir site is feasible on the lower reach of the stream, with the dam a very short distance from the Youghiogheny River, and more extensive investigations might show that the coal deposits are not of sufficient importance to interfere with a project of large capacity in this valley.

INDIAN CREEK.

Indian Creek flows from the western slope of Laurel ridge in the southeastern part of Westmoreland County, and following a southwesterly course shortly enters Fayette County, in which it joins the Youghiogheny River, on the right bank, 51 miles from the mouth of that stream. The mouth, which is 7 miles above Connellsville, has an elevation of about 953 feet.

The basin, which has a greatest length of 20 miles and an average width of 6.3 miles, has an area of 126 square miles about evenly divided into two parts by the creek. On the northwest is the Chestnut ridge and on the southeast the Laurel ridge, the latter largely forming the Fayette-Somerset county line. About 67 per cent of the basin is under forest cover, of which by far the greater part lies on the above named ridges.

Some three miles above the mouth of the stream the Pennsylvania Railroad Company has built a reservoir from which water is conducted for supply purposes to various parts of their main railroad and branch system, to the north and northwest.

The coals have been eroded from the crests of the ridges on either side, but most of the valley, high up on the slopes, holds several beds of the Allegheny formation, which are mined to a limited extent. A railroad called the Indian Creek Valley Railroad, recently built and at this time arriving at only a small business, extends from the Baltimore & Ohio Railroad, on the Youghiogheny River, to a point 12 miles upstream.

This valley has not been covered by a government topographic survey. A field examination disclosed the fact that a reservoir of adequate size could probably be built, but present developments discouraged the making of surveys. Later studies might show that some arrangement could be made for the enlargement of the present reservoir to a capacity sufficient to serve the additional purpose of flood control.

REDSTONE CREEK.

Redstone Creek rises in Chestnut ridge 2540 feet above tide and after flowing a distance of 29 miles in a general northwesterly course, joins the Monongahela River, on the right bank, at an elevation of 735 feet, 55.2 miles above Pittsburgh. Compared to most of the lower Monongahela tributaries, the average fall per mile is very steep, being about 62 feet. For a distance of 11 miles above the mouth the fall is 15 feet per mile, and from Uniontown, population 13,350, 21 miles above the mouth, the fall is about 11 feet per mile.

The drainage basin, which lies entirely in Fayette County, has an area of 109 square miles, of which 14 per cent is wooded. Elevations of the higher hills range from 1300 feet along the sides of the lower half of the basin to about 2800 feet near the source.

The valley for the greater part is narrow, but for a distance of several miles above the mouth it broadens out. At the Monongahela River the Pittsburgh coal bed is

above water, but dips under water a short distance upstream and reappears, probably eight miles from the mouth, from which point the outcrop rises back on the hills. Small towns are scattered along the valley and a number of mines are in operation. The Redstone branch of the Pennsylvania Railroad closely follows nearly the entire length of the stream.

This stream is not considered suitable for a flood control project.

TEN MILE CREEK.

Ten Mile Creek drains the southeastern part of Washington County and the northeastern part of Greene County. In fact, nearly half of the latter is covered by the drainage of the South Branch, which is the larger tributary, and joins the North Branch at the village of Clarksville, from which place the main stream flows eastwardly three miles, entering the Monongahela on the left bank 65.7 miles from Pittsburgh.

The stream, by the South Branch, has a length of 40 miles and falls from an elevation of 1280 feet at the source to an elevation of 747 feet at the mouth. It has a very irregular discharge and in some years the surface of the bed has been completely dry. No measurements of flood discharge have been made, but it is known that the stream rises to considerable height.

The basin, nearly circular in form, drains 334 square miles, with the watershed reaching elevations ranging from 1300 to 1500 feet. About 18 per cent of the basin is wooded.

While the topography is well formed for a reservoir on the lower reach of each of the branches, or for one large project on the main stream, with the dam below Clarksville, the underlying Pittsburgh coal bed, it is thought, would interfere with economical use of this valley. The depth of the coal below stream bed, probably 120 feet at Clarksville, would permit of a reservoir being built if the mining could all be done from one end, but, as shaft and other mine features would probably be needed along the stream, it has discouraged anything being done beyond the field examination. An extensive mining and coking plant, with railroad connections, is located on the main stream.

WHITELEY CREEK.

Whitely Creek is situated in the southeastern part of Greene County and after flowing almost due east to Mapleton, a distance of 16 miles, and then northwardly 5 miles, enters the Monongahela River on the left bank, 80.5 miles above Pittsburgh. The elevation at the source is 1340 feet and at the mouth 760 feet.

The drainage basin has an area of 52 square miles and the higher parts of the divide reach elevations of from 1400 to 1500 feet. About 18 per cent of the basin is wooded. Several favorable reservoir sites of suitable capacity are to be found on the lower reaches, but have not received consideration on account of the presence of the Pittsburgh coal, which underlies the stream mouth at a depth of about 130 feet, and at Willow Tree, 8.5 miles above the mouth, lies at a depth of probably over 300 feet. Extensive developments have not been made along this stream, and mining requirements including rail connection are not known.

GEORGE CREEK.

George Creek is situated in Fayette County and has its source on the western slope of the Chestnut ridge, at an elevation of about 1160 feet. From the source it flows 16 miles, almost due west, joining the Monongahela River on the right bank at New Geneva, 85.2 miles from Pittsburgh. The elevation of the mouth, in pool No. 7, is

770 feet. The average per mile slope of the entire stream is 24 feet, with the flatter portion in the upper half.

The area of the drainage basin is 66 square miles, of which 21 per cent is wooded. At the mouth of the stream the Pittsburgh coal bed is back in the hills and something over 230 feet above water. The lower coal measures, with the overlying bed, the Upper Freeport, would be about 300 feet under water. This condition, in a general way, is believed to continue for a number of miles up the creek, and it is therefore seen that coal is not a matter for concern, as was thought to be the case at the time of the field reconnoissance.

The Fairmont and Morgantown branch of the Baltimore & Ohio Railroad enters the valley from the north, following the stream for some miles and leaving it seven miles above the mouth, at a point a short distance north of a place called Outcrop. The valley is comparatively narrow and little developed, and reservoiring is feasible on an adequate scale.

DUNKARD CREEK.

Dunkard Creek rises in the southwestern corner of Greene County, Pennsylvania, and by a general but meandering course follows the state line for a distance of 32 miles, when it turns northeastwardly 15 miles, joining the Monongahela River, on the left bank, 87.5 miles above Pittsburgh. The stream has a length of 47 miles, and falls from an elevation of 1240 feet at the source to 770 feet at the mouth, which is immediately below Lock No. 8. The drainage basin, of which about half lies in West Virginia, has an area of 229 square miles, about 18 per cent of which is under forest cover. The higher hills of the surrounding divide reach altitudes of about 1400 feet.

The discharge is subject to wide variations and the stream goes dry in summers of low rainfall, as in 1908. A gaging station is in operation a few miles above the mouth, but no measurements of flood flow have as yet been obtained.

The average fall of the stream, from the source, is about 10 feet per mile, or only slightly greater than the West Fork, which has a lower rate than any of the other streams. The stream slope from the mouth to Mount Morris, 12 miles, averages about 10 feet to the mile, while from the mouth to Blacksville, 30 miles, the slope is 5.7 feet to the mile. Along this whole part of the valley the topography is particularly well formed for reservoir construction to large capacity. No railroads have been built along the stream, but two sites would probably be required to avoid interference with several villages.

This valley, however, has not been included in the study for reservoir projects, on account of the Pittsburgh coal bed which underlies the stream. The coal at the mouth is approximately 200 feet above water and about three miles from the mouth it disappears under water, rapidly descending to 350 feet under water, at Mount Morris.

It is considered that a dam could be built a short distance upstream from the point where the coal goes under water, without any detriment to mining operations, but it was not possible at this time to make the careful investigation thought necessary to arrive at a plan which would harmonize with mining requirements.

DECKERS CREEK.

Deckers Creek rises in the eastern part of Monongalia County, W. Va., flows southwestwardly into Preston County, returns into Monongalia County, in a northwesterly course, and enters the Monongahela River on the right bank at Morgantown, 102.2 miles above Pitsburgh. The stream falls in a total distance of 24 miles, from an elevation at the source of 2140 feet to an elevation at the mouth of 793 feet. For 5.5

miles above the mouth, the fall per mile is 37 feet, and for the next 4.5 miles it is 103 feet per mile.

The basin has an area of 62 square miles, of which 47 per cent is wooded. The higher parts of the watershed reach altitudes of 2200 to 2300 feet.

The Morgantown & Kingwood Railroad follows the stream for a distance of about 17 miles from the mouth, and several mines and a number of coke ovens have recently been established on this road, about four miles from the mouth. Coal is also mined some miles further up the stream. It is understood that the Upper Freeport coal bed is the one which is mined in this district.

Railroad and mine developments have discouraged anything being done on this stream beyond the field examination and a study of the government topographic maps and the geological data of West Virginia.

BUFFALO CREEK.

Buffalo Creek and its branches lie within the limits of Marion County, West Virginia. Most of the western half of the county is drained by this basin, which has an area of 122 square miles. About 16 per cent of the basin is wooded. The higher parts of the watershed surrounding the basin reach elevations ranging from 1400 to 1600 feet.

The stream flows eastwardly a distance of 28 miles from an elevation of 1260 feet, and joins the Monongahela River on the left bank, 125 miles above Pittsburgh. The mouth of the stream, elevation 858 feet, is 1.7 miles below the city of Fairmont and to this point, from the town of Mannington, which is 17 miles above, the stream falls at the rate of 6.0 feet per mile.

The immediate valley, for the most part, is comparatively narrow, and close along the stream is located the Wheeling Division of the Baltimore & Ohio Railroad. The Pittsburgh coal bed is mined at a number of places, and in view of the conditions obtaining, it is believed, judging from a rapid field examination and study of the U. S. Geological Survey maps, that reservoiring could not be effectively carried out, for reasonable cost.

TYGART VALLEY RIVER.

Tygart Valley River, West Virginia, as a tributary of the Monongahela River, ranks third in length and in drainage area. The drainage basin has an area of 1369 square miles and includes portions of nine counties, namely, Pocahontas, Randolph, Upshur, Barbour, Tucker, Preston, Taylor, Marion and Monongalia. This stream, with the West Fork, forms the Monongahela, the junction occurring about one mile above Fairmont, and 128.1 miles above Pittsburgh. The source is in the extreme southern part of Randolph County, and from here the general course of the stream is a little west of north. The elevation at the source is 4100 feet, and in the 118 miles from here to the junction with the West Fork, at the head of pool No. 15, the end of slackwater improvement on the Monongahela River, the stream drops 3242 feet to an elevation of 858 feet.

The fall per mile of the stream by long reaches is as follows: head of stream to Mingo Flat, 4.8 miles, 293.7 feet; thence to Huttonsville, 17 miles, 36.5 feet; thence to Belington, 36 miles, 10.8 feet; thence to Philippi, 17 miles, 22.8 feet; thence to Grafton, 23 miles, 13.8 feet; thence to mouth, 20 miles, 5.9 feet.

The Tygart Valley has two tributaries of considerable drainage area, namely: Buckhannon River, of 304 square miles, and Middle Fork, of 152 square miles. The former enters 48 miles and the latter 52 miles, above the junction with West Fork.

At the very head of the basin, and near the source of the stream, is a high point on Cheat Mountain, called Mace Knob, with an elevation of 4700 feet. Cheat Mountain separates this valley from that of Shavers Fork northwardly for nearly 40 miles, the higher elevations falling in this distance to 4000 feet. On the west, in the same distance, the divide falls to about 2000 feet, to the west of the Buckhannon. The higher parts of the eastern divide, upon nearing the mouth, gradually lower to about 2000 feet, while on the west, the divide is considerably lower. Laurel ridge, which is prominent in Pennsylvania, reaches the edge of the basin three miles west of Rowlesburg, and from here it continues southwardly, forming the divide for a distance of about 16 miles; then enters the basin, finally taking the name of Rich Mountain, and again touches the watershed at Mace Knob, at the head of the Buckhannon River.

About 43 per cent of the basin is under forest cover, 8 per cent of which is composed of virgin forest, occurring in practically two areas, one situated at the headwaters of the Middle Fork branch and the other at the headwaters of the main stream. About 7 per cent of the wooded area has been burned over. By far the greater area of the woodland covers the high country of the basin, which begins with and lies to the south and southeast of the Laurel-Rich mountain range and to the west of this range across the upper waters of the Buckhannon and Middle Fork.

The upper portion of this basin receives the heaviest rainfall recorded on either the Allegheny or Monongahela Basins, the maximum annual rainfall at Pickens reaching 80.9 inches in 1907.

Since June, 1907, when observations began, the maximum discharge at Fetterman, W. Va., 19 miles above the mouth, from a drainage area of 1296 square miles, has been 34,975 second-feet, or 27.0 second-feet per square mile, and the minimum, 12 second-feet, or 0.0093 second-foot per square mile. The maximum recorded stage of 29.0 feet occurred in July, 1888, when there was a discharge of 56,600 second-feet, or 43.6 second-feet per square mile. There is a difference of 26 feet between high and low water at Fetterman.

The maximum discharge, 60 miles above the mouth, at Belington, W. Va., where the drainage area is 404 square miles, is 17,700 second-feet, or 43.8 second-feet per square mile. This maximum, as at Fetterman, occurred during the flood of July, 1888. The minimum discharge is 7 second-feet or 0.017 second-foot per square mile. There is a difference of about 18 feet between high and low-water stages at Belington.

From the source to a point about five miles above Huttonsville, the valley is found to be narrow and thinly-settled. Following down the valley, to the crossing of the Laurel ridge, three miles below Elkins, there is almost continuous bottom land, much of it being nearly a mile wide. Between Belington and the mouth of the Buckhannon the valley is narrow and gorge-like. Below the mouth of this stream to Grafton, the valley, although still sided by steep hills, opens out into bottom land of limited extent, principally at and near Philippi, and at Grafton. Between Grafton and the mouth the hills again close in near to the stream.

According to the West Virginia geological map, the eastern edge of the Allegheny coal formation crosses the river about six miles west of Elkins, the limit of the field being along the western slope of Laurel ridge and close to the crest of that range. From this point to within about 9 miles of the Monongahela River, the valley holds beds of this formation, and along this stretch of the stream coal is mined at a number of places on the banks. For two or more miles above the mouth the stream flows between coal areas, which are said to be considerably above water.

The Baltimore & Ohio Railroad closely follows the stream from the mouth to Bel-

ington, from which place the Western Maryland operates a line as far as Huttonsville. The principal towns and their populations are as follows: Huttonsville, 250; Beverly, 440; Elkins, 5260; Belington 1480; Philippi, 1040; Grafton, 7560.

The topographic conditions and the fall of the stream are favorable for several sites in this valley, below or above Grafton, but it is considered from the field examination, and study of the U. S. Geological Survey maps, that large projects would be too costly for the value received. Further and more extensive investigations might show, however, that by very careful adjustment, one or two sites could be secured without too much interference with mine, town and railroad developments and that the flood control to be obtained thereby would warrant the cost.

THREE FORK CREEK.

Three Fork Creek rises in the western part of Preston County, West Virginia, at an elevation of 1930 feet, flows southwestwardly 25 miles, entering Taylor County, and joins Tygart Valley River at Grafton, on the right bank, 20 miles above the mouth. The elevation of the mouth is 975 feet. The area of the drainage basin is 103 square miles, of which nearly 39 per cent is wooded.

The main east and west line of the Baltimore & Ohio Railroad closely follows the stream from the mouth to a point 10 miles above, where it turns up a branch called Raccoon Creek and crosses an arm of Laurel ridge and then the Cheat River.

The topography is formed suitably enough for one or more reservoir sites, but railroad developments would make adequate projects too costly, and none have been considered.

TEN MILE CREEK.

(Of the West Fork River.)

Ten Mile Creek has its source in the southwestern part of Harrison County, W .Va., at an elevation of 1280 feet, flows northeastwardly a distance of 28 miles and joins the West Fork River, on the left bank, at an elevation of 895 feet, 18 miles from the mouth of that stream.

The area of the drainage basin is 126 square miles and the higher parts of the surrounding hills reach elevations of from 1300 to 1600 feet. About 21 per cent of the basin is wooded.

A line of the Baltimore & Ohio Railroad, which branches off the main road at Clarksburg, descends the West Fork River, follows up Ten Mile Creek to the mouth of Little Ten Mile and then ascends this stream. The Pittsburgh coal is mined at a number of places along the railroad.

The main valley is narrow, with the exception of a short reach at the mouth of Little Ten Mile. Below this point one, or possibly two, dam sites are feasible, ponding the water up both the main stream and the branch. It is thought, however, that the damages to railroad and coal interests would not warrant a project on this stream, particularly as the effective results from this section are comparatively small.

MAINTENANCE AND OPERATION.

For the proper maintenance and operation of the reservoir system, a well-organized and efficient force would be a necessity. This work would be directed from a central office at Pittsburgh, connected by telephone with each of the reservoirs and with the various rainfall and stream-gaging stations.

At each gate house there should be on duty at all hours of the day and night, an at-

tendant with a sufficient number of helpers, to care for the varied requirements of the reservoir system. During the flood periods, the opening and closing of the reservoir gates, in conjunction with similar operations at the other reservoirs, would require constant watchfulness and intelligent supervision. During summer or dry-weather periods, the same careful and intelligent regulation of the gates would be necessary, in order to so operate the reservoir system as to render the greatest possible aid to navigation, water power and other interests.

There would also be required, at each reservoir, a limited amount of patrol service, together with work of local repair and upkeep. During the summer months, this would include more or less work in the nature of keeping in a sanitary condition portions of the reservoir bed, which, to some extent, would receive a deposit of mud and other debris during high water.

An efficient and well-organized force, rather than a large force, would best serve the purpose of this reservoir regulation and upkeep. It would probably be unnecessary to retain other than the regular attendants at any one reservoir, the laborers being shifted from reservoir to reservoir, as required by the service, or temporarily hired in the locality.

Ready and reliable intercommunication between each reservoir and the central Pittsburgh office would be a necessity. To accomplish this, the drainage area above Pittsburgh could be divided into three telephone districts, each having its own local exchange. One, or the central district, could have its exchange in the Pittsburgh office, and the other two, covering the northern Allegheny and the Monongahela Basins respectively, could have their exchanges at conveniently located points, from which reports could be made to headquarters at Pittsburgh. Such service would not only be invaluable at times of flood, when hourly information as to conditions at all points of the drainage area would be essential, and orders for reservoir regulation must be given on short notice, but during all periods of the year, it would serve to inform the central office of the reservoir system as to rainfall and stream-flow conditions, amount of water in reservoirs, etc., so that orders could be given for the distribution of men and work and for the efficient control and operation of the reservoirs.

The estimate of the annual cost of telephone service given below is based on figures furnished by the Bell Telephone Company. This contemplates the operation of 17 regular telephone stations, one at each of the reservoir projects, together with the communication, by means of toll stations, with about 30 other points from which rainfall and river stages would be reported.

The annual expenditure necessary to maintain and operate the reservoir system would be divided about as follows:

Central office at Pittsburgh, including engineering, clerical, traveling expenses, etc.	$ 40,000
At Reservoirs—	
Regular attendants	45,000
Repairs, etc.	60,000
Telephone service	7,500
Operation of stream-flow and rainfall stations	2,500
	$155,000
Contingencies	45,000
Total	$200,000

CHAPTER VII.

FLOOD PREVENTION BY STORAGE RESERVOIRS.

Ideal Conditions for Reservoir Control—Actual Conditions—Extent of Studies—Difficulties Encountered—Peak Reduction Studies—Peak Reduction Diagrams, 43 Projects—Studies of Effectiveness—Selection of Projects—28 Projects—Seventeen Selected Projects—Summary—Peak Reduction Diagrams, Seventeen Selected Projects—Possible Maximum Flood—Conclusion.

IDEAL CONDITIONS FOR RESERVOIR CONTROL.

The prevention of Pittsburgh floods by means of storage reservoirs does not necessitate the storage of the entire flood wave. The only part that must be held back is that rising above the danger mark, or stage where flood damage begins. If all storms causing floods were exactly alike in distribution of run-off, and if the various tributaries invariably entered into the formation of the Pittsburgh flood crest in the same proportion and in the same relative position with reference to the peak, the solution of the problem would be simple and comparatively inexpensive. In such case, an analysis of the crest of the maximum past or greatest possible future flood would determine which tributaries brought their flood waters to Pittsburgh during the critical interval of damaging flood height. It would then be necessary merely to select and construct upon these tributaries storage equal to the volume of this maximum flood crest above the danger line. In the case of the 1907 flood, this necessary capacity would have been only 25,800,000,000 cubic feet; whereas the total volume of the flood wave was about 76,000,000,000 cubic feet, or three times the above capacity. Storage to the amount necessary for the control of this flood could be selected and constructed for less than $12,000,000; that is, for less than the actual losses from flood damage in the last ten years at Pittsburgh alone.

ACTUAL CONDITIONS.

The rainfall, however, varies widely in amount, in distribution and in time of arrival. Moreover the run-off on a given part of a drainage area may vary widely even with the same rainfall. It is affected by the condition of the ground, whether saturated, dry or frozen; by the presence of snow on the ground and the condition of that snow, whether packed and icy, or soft and easily melted; and by the temperature before, during and after the rain. In short, an infinite number of combinations may be conceived; and it is obvious that no two floods are alike. The stages reached at Pittsburgh may be identical, but the origins of the respective floods are never exactly the same. It is necessary, therefore, that the volume and distribution of storage shall be adequate to control all possible conditions and combinations of run-off.

EXTENT OF STUDIES.

The probable reduction in gage heights at Pittsburgh due to reservoir control has therefore been studied for the eleven principal floods from 1898 to 1908. Prior to 1898 the rainfall records are confined to a comparatively few stations adaptable to these studies. On a few streams gagings have been made during this period and furnish most satisfactory data for this work. The majority of the tributary flood waves, however, have been computed from the rainfall records.

DIFFICULTIES ENCOUNTERED.

The principal difficulties met with in this study were:

(*a*) The lack of sufficient detailed rainfall data; *i. e.*, the Weather Bureau records give the results as obtained from rain gages read usually at 8 A. M. each day, and it is impossible to ascertain from these records during what part of the twenty-four hours the rain fell.

(*b*) The lack of adequate records of the snow on the ground at the beginning and end of the rainfall, there being no record of this prior to 1902, when the monthly bulletins of the Weather Bureau were started; and even in these bulletins since 1902, only a very indefinite statement as to the amount and location of the snow on the ground.

(*c*) The necessity for an arbitrary assumption as to the time of movement down each tributary to the dam nearest the mouth; *i. e.*, the time of collection.

METHOD OF TREATMENT.

Treatment of (*a*). It was assumed that on the day of the greatest rainfall the rain fell throughout the twenty-four hours at a uniform rate. The hourly rate of rainfall for that day, therefore, would be the total rainfall divided by twenty-four. If either the day before or the day after, or both, had rainfall, it was assumed that this rain fell at the same rate as on the principal day. The amount of rainfall on these days, therefore, was divided by the hourly rate obtained for the principal day and the number of hours of rainfall during these two days obtained in this manner. If there were more than three consecutive days of rainfall the first and last days were assumed to have their rainfall at the same rate as the following and preceding days respectively. In this way a time of starting and stopping of the rain storm was determined for purposes of calculation.

Treatment of (*b*). In the consideration of floods prior to 1902, where no snow records whatever are available, it has been assumed, in order to be conservative, that there was no snow on the ground at the time of the flood. For the floods since 1902, an estimate of the amount of snow has been made from a study of the Weather Bureau bulletins, and 100 per cent of this snow has been assumed to melt and run off with the rainfall.

Treatment of (*c*). It has been assumed that after the beginning of the rainfall it takes one hour for the water running off to get to the small tributaries; two hours for it to travel through these small tributaries; and a certain number of hours, varying with the particular stream, for the water to travel the length of the stream to the dam nearest the mouth. This time of travel down to the dam has been estimated in each case from a study of the average slope, the shape and size of the drainage basin, the distance to be traveled, and, where records are available, from an inspection of the velocities during discharge measurements.

The times of movement down the main rivers have been computed by means of the Chezy formula from the best available information. On the Allegheny River, the surveys of the U. S. Engineers furnished slopes, cross-sections, etc., together with a profile of the flood of 1865. On the Monongahela River, similar data were obtained from the U. S. Engineers' surveys, where available, and from the U. S. Geological Survey topographical sheets. Plate 52 shows the time of movement of floods on these rivers. As is to be expected on account of the greater slope of the Allegheny, the time of movement of floods down its channel to Pittsburgh is considerably less than on the Monongahela.

PEAK REDUCTION STUDIES.

The study of the Pittsburgh flood peak reductions was made in a graphical manner as follows:

The flood peak at Pittsburgh was first plotted, using discharges in second-feet as ordinates and hours as abscissae. The discharges were obtained by means of gage heights obtained from the U. S. Weather Bureau and an approximate discharge curve for the Ohio River at Pittsburgh based on measurements by the U. S. Engineers.

The individual flood peaks on the tributaries favorable for storage were then constructed. For this purpose, 75 per cent of the flood rainfall was estimated to run off, on the assumption that the ground being in a frozen condition, a large percentage of run-off would result. Where there were records of snow on the ground, as previously stated, 100 per cent of this depth of melted snow was assumed to run off with the rainfall. The equivalent total run-off in cubic feet per second per square mile was multiplied by the drainage area above the dam nearest the mouth, giving the maximum discharge for that particular flood. There have doubtless been cases where the above percentage of rainfall running off has been exceeded and where it has reached practically 100 per cent, especially with snow and frozen ground; but this conservative figure of 75 per cent has been considered best for these studies, in order that the flood controlling effect of the respective projects might not be overestimated by reason of too large an estimate of the flood waters delivered by the corresponding drainage areas controlled.

The flood flow of a given stream was assumed to start at zero at the time of the beginning of the rain and rise to the maximum flow due to this run-off in the number of hours estimated for time of collection. It was continued at this rate until the rain stopped or changed. If the rain stopped, the flood flow was decreased to zero in the same number of hours it took to rise to its maximum. If the rate of rainfall increased or diminished, the rate of discharge was increased or diminished in the same number of hours to the new rate corresponding to the new rainfall and continued at this rate until the rain stopped, when it was decreased to zero in the same number of hours it took to rise.

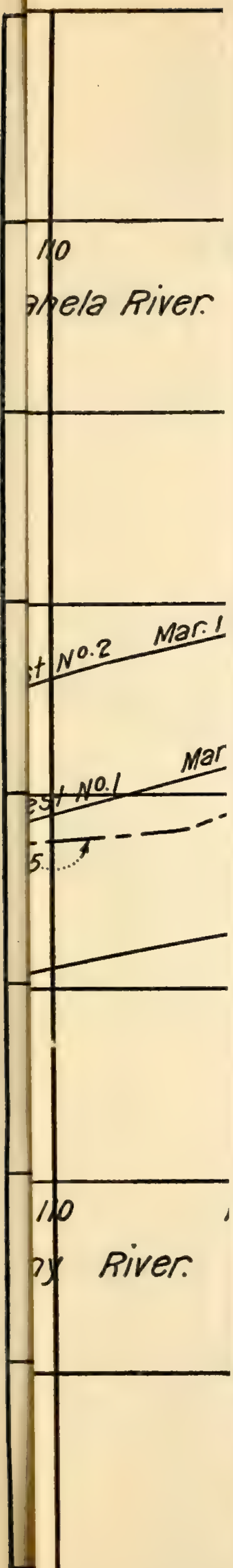
On the Cheat River, gage heights and corresponding discharges are available for all these floods and have been used instead of discharges estimated from rainfall. On the Clarion River, similar data are available for all except the floods of 1898, 1900 and 1901. On Black Lick Creek these data are available for the floods considered in 1905, 1907 and 1908.

These tributary flood peaks were then moved ahead by the number of hours required for them to travel to Pittsburgh, and plotted in their resulting positions below the Pittsburgh flood peak. On account of their smaller size, they were plotted to twice the scale of the Pittsburgh flood peak. The sum of their ordinates, that is, one-half the graphical sum, on account of the difference in scales, was then deducted from the corresponding ordinate of the Pittsburgh flood peak, and the reduced Pittsburgh flood peak was formed from a series of points thus obtained.

COMPARISON OF ACTUAL AND ESTIMATED FLOOD WAVES.

The following computations and the diagrams on Plate 54 are inserted to enable a comparison of the results obtained by computing the run-off from precipitation records with the results obtained from actual stream gagings.

The upper diagram shows in graphical form the flood discharge of March, 1907, on Black Lick Creek. As indicated in the method described above, the rainfall for the 24 hours preceding 8 A. M. on the 13th, (1.30 inches), has been divided by 24, and 75 per


110
ahela River.
st No.2
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est No.1
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110
ny River.

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The flood peak at Pittsburgh was first plotted, using discharges in second-feet as ordinates and hours as abscissae. The discharges were obtained by means of gage heights obtained from the U. S. Weather Bureau and an approximate discharge curve for the Ohio River at Pittsburgh based on measurements by the U. S. Engineers.

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The flood flow of a given stream was assumed to start at zero at the time of the beginning of the rain and rise to the maximum flow due to this run-off in the number of hours estimated for time of collection. It was continued at this rate until the rain stopped or changed. If the rain stopped, the flood flow was decreased to zero in the same number of hours it took to rise to its maximum. If the rate of rainfall increased or diminished, the rate of discharge was increased or diminished in the same number of hours to the new rate corresponding to the new rainfall and continued at this rate until the rain stopped, when it was decreased to zero in the same number of hours it took to rise.

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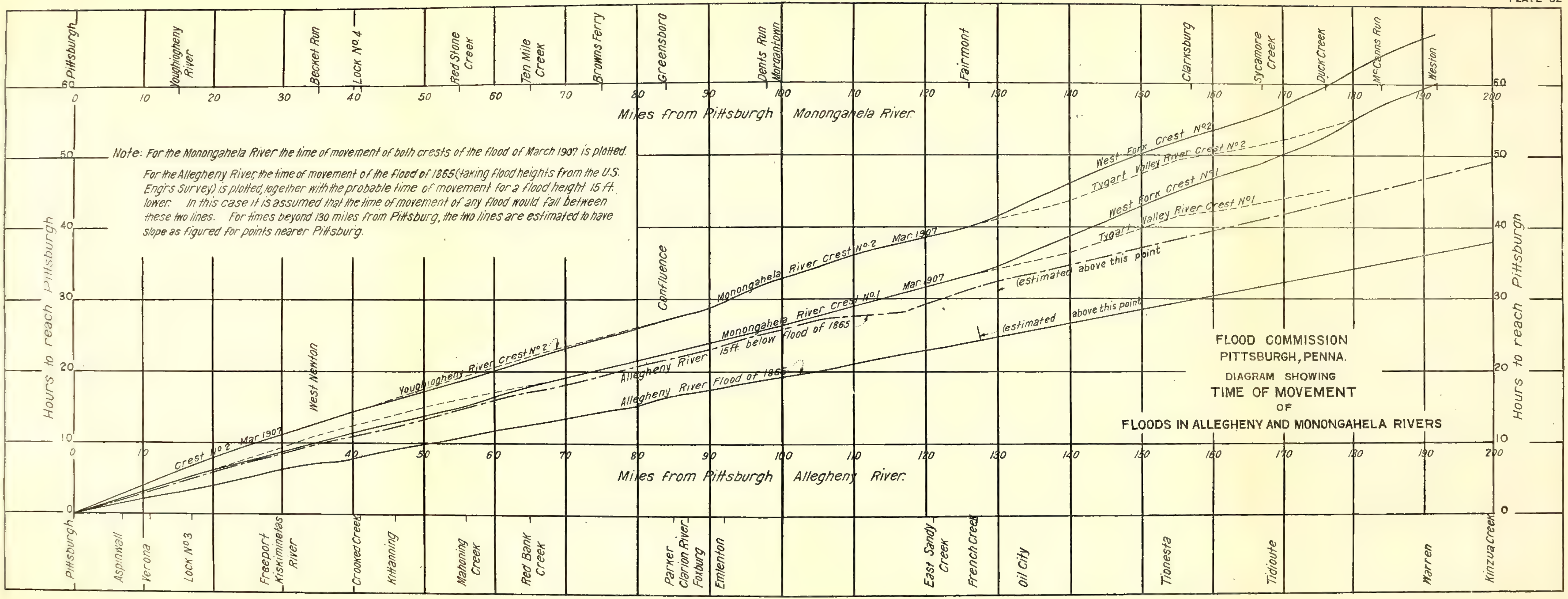


Note: For the Monongahela River the time of movement of both crests of the flood of March 1907 is plotted.
For the Allegheny River, the time of movement of the flood of 1865 (taking flood heights from the U.S. Engrs Survey) is plotted, together with the probable time of movement for a flood height 15 ft. lower. In this case it is assumed that the time of movement of any flood would fall between these two lines. For times beyond 130 miles from Pittsburg, the two lines are estimated to have slope as figured for points nearer Pittsburg.
Miles from Pittsburgh Monongahela River
Miles from Pittsburgh Allegheny River
Hours to reach Pittsburgh
Pittsburgh
Youghiogheny River
Becket Run
Lock No. 4
Red Stone Creek
Ten Mile Creek
Browns Ferry
Greensboro
Dents Run
Morgantown
Fairmont
Clarksburg
Sycamore Creek
Duck Creek
McCanns Run
Weston
West Newton
Confluence
Aspinwall
Verona
Lock No 3
Freeport
Kiskiminetas River
Crooked Creek
Kittanning
Mahoning Creek
Red Bank Creek
Parker
Clarion River
Foxburg
Emlenton
East Sandy Creek
French Creek
Oil City
Tionesta
Tidioute
Warren
Kinzua Creek
West Fork Crest No 2
Tygart Valley River Crest No 2
West Fork Crest No 1
Tygart Valley River Crest No 1
Monongahela River Crest No 2 Mar. 1907
Monongahela River Crest No. 1 Mar. 1907
Youghiogheny River Crest No 2
Crest No 2 Mar 1907
Allegheny River 15 ft. below flood of 1865
Allegheny River Flood of 1865
(estimated above this point
(estimated above this point
FLOOD COMMISSION
PITTSBURGH, PENNA.
DIAGRAM SHOWING
TIME OF MOVEMENT
OF
FLOODS IN ALLEGHENY AND MONONGAHELA RIVERS

PLATE 53

PRECIPITATION RECORDS

STATION	March 20, 1908 Gage Height 27.3 ft					February 16, 1908 Gage Height 30.7 ft					March 15, 1907 Gage Height 35.5 ft				
	17	18	19	20	21	13	14	15	16	17	11	12	13	14	15
Saegerstown	0.02	0.50	0.26	—		0.20	0.16	0.97	0.14	0.07		0.12	0.27	0.25	
Erie	T	0.06	0.03	—		0.04	0.69	0.30	0.09	0.04		0.11	0.53	0.12	
Franklin	T	1.30	0.10	—		0.18	0.80	T	T	0.10		0.10	0.34	0.46	
Oil City															
Clarion	—	—	1.60	—		0.04	0.20	0.68	0.52	0.06	0.02	0.04	0.62	0.54	
Warren	—	1.07	1.10			0.21	0.03	1.10	0.10			0.06	0.13	0.64	
Parkers	—	0.22	1.02	—			0.04	1.70	0.30	0.30	0.12	0.04	0.80	0.74	
St Marys	—	0.38	0.22				0.50	0.60	0.15	0.05	—	T	0.35	m.	
Ridgeway												0.01	0.35		
Brookville															
Jamestown	—	0.15	0.09	0.02								0.05	0.25	0.16	
Indiana	—	1.05	1.32	—			0.30	0.90	0.20	0.05		0.50	1.30	1.25	0.25
Freeport	—	0.17	1.81			0.04	0.18	0.69	0.21	0.03		0.04	1.85	0.92	
Hawthorn															
Saltsburg	—	0.01	1.78			0.01	0.06	0.42	0.24	0.08	0.28	0.04	1.28	0.94	0.12
Derry	—	2.22	0.70			T	0.36	0.70	0.10	—		0.10	1.49	1.41	
Lycippus	0.13	3.19	T			0.03	0.76	0.28	0.09	T	0.02	1.40	1.75	0.12	
Johnstown	—	2.70	0.85			T	0.34	0.46	0.18	0.10		0.25	1.50	1.01	
Cassandra											0.30	—	2.00	1.25	
Weston	0.10	0.22	0.74				0.16	0.80	0.36	0.38			0.58	1.12	
Lost Creek	0.10	0.07	1.10			0.03	0.35	0.54	0.08	T		0.52	1.04	0.38	
Glenville	T	0.27	T			T	0.28	0.83	T	T		0.60	0.10	1.05	
Buckhannon															
Phillipi	0.01	T	1.12			0.01	0.27	0.91	0.25	0.08		0.24	1.40	0.70	
Clarksburg															
Rowlesburg	0.04	0.01	1.74				T	0.72	0.46	0.14		0.04	1.46	1.12	
Grafton	0.05	0.04	1.38			0.11	0.18	0.60	0.02	0.01		0.33	1.40	0.80	
Fairmont	—	0.08	1.10												
Parsons													2.50	0.50	
Pickens	—	0.50	1.10			T	T	0.20	0.40	0.50	0.00	0.95	0.90	0.45	
Terra Alta	—	0.10	1.55			T	0.22	0.80	0.30			0.22	1.84	0.95	
Morgantown	—	0.49	0.90				0.36	0.46	0.20	T		0.15	1.70	1.40	
Confluence	—	T	1.98				T	0.60	0.10				1.33	1.80	
Somerset	—	1.76	0.28				0.28	0.20	0.35			0.20	1.58		
Oakland	—	0.30	1.50			0.02	0.05	1.20	0.40	0.10		0.04	1.00	0.50	
Grantsville	—	0.82	1.15			0.10	—	—	0.40	—		0.05	2.50	0.95	
Deer Park	—	0.45	1.25				0.15	0.72	0.40	0.20			2.60	0.45	
Elkins	0.11	0.03	0.72			T	0.22	0.73	0.08	0.06		0.42	0.32	0.44	
Aleppo															

STATION	March 22, 1905 Gage Height 29.0 ft					March 4, 1904 Gage Height 26.9 ft					January 23, 1904 Gage Height 30.0 ft				
	19	20	21	22	23	1	2	3	4	5	20	21	22	23	24
Saegerstown	0.58	0.12	0.37	—		0.79	—	0.97	—		0.37	0.93	1.38	0.03	0.03
Erie	0.24	0.03	0.13	0.01		T	T	0.60	T		0.51	1.01	1.27	0.03	0.05
Franklin	1.25	—	0.48	—							0.46	1.53	0.23	T	T
Oil City	0.82	0.68	0.18	0.28		1.36	—	0.68	0.36		0.04	1.08	1.32	0.02	0.04
Clarion	0.76	1.26	0.30	0.16		1.06	—	1.36	0.60		T	0.94	1.24	0.04	0.01
Warren	1.50	0.56	0.36	T		1.02	—	0.52	—		0.06	0.12	0.38	0.04	T
Parkers	0.80	0.30	0.28	0.10		0.84	—	1.30	0.40		T	0.80	1.20	T	T
St Marys	1.25	0.27	0.42	—		—	—	1.85	—		0.40	0.40	1.00	0.80	—
Ridgeway															
Brookville						0.88	—	1.50	0.76			0.84	1.36	0.12	
Jamestown						0.86	—	0.70	—						
Indiana	0.38	—	1.14	0.03		0.40	—	1.80	—		0.06	0.62	0.50	0.03	—
Freeport	0.23	0.41	0.50	0.25		—	—	2.33	—		0.70	0.49	0.37	—	T
Hawthorn											0.05	2.00	0.60	—	—
Saltsburg	0.26	0.42	0.54	0.30		0.64	—	0.80	0.76		0.01	0.72	0.52	0.06	0.04
Derry	0.69	—	0.85	—	0.31	—	—	1.38	—		0.29	0.60	0.31	0.10	
Lycippus	0.38	0.52	0.19	—		—	0.01	0.82	—		0.66	0.50	0.13	0.01	
Johnstown	0.52	0.46	0.80	0.40	T	0.48	—	1.14	0.02		0.65	0.53	0.41	0.01	0.03
Cassandra	0.43	0.20	0.37	—		—	—	0.75	—		0.16	0.54	0.18	0.06	—
Weston	0.60	0.43	0.83	0.01		0.08	T	0.70	—		0.10	0.12	0.38		
Lost Creek	0.67	0.41	1.09	T											
Glenville	0.37	0.40	0.90			0.03	—	0.81	—		0.37	1.62	1.20	0.01	0.02
Buckhannon											0.77	—	0.41		
Phillipi	0.50	0.24	1.37			0.05	—	0.60	—		0.25	0.04	0.40	0.20	
Clarksburg															
Rowlesburg						0.40	—	—	0.86			0.20	0.36	0.62	
Grafton	0.71	0.29	1.23	0.01		0.13	—	0.68	T		0.14	0.04	0.31	0.06	
Fairmont						0.16	—	0.90	—		T	0.26	0.20	0.22	
Parsons		0.50	0.90			—	—	0.65	—						
Pickens						0.22	—	0.48	—						
Terra Alta	0.82	0.50	1.35			0.13	T	0.25	T	T	0.20	T	0.40	—	—
Morgantown		1.12	1.30			0.20	—	0.75	—		0.12	0.12	0.27	0.06	
Confluence	0.40	0.70	0.80	0.42		0.30	—	—	0.88			0.34	0.38	0.18	T
Somerset	0.88	0.66	0.40			—	—	0.50	—		0.65	—	0.45	0.35	
Oakland	0.10	0.10	0.12	—	0.05	—	—	1.00							
Grantsville	0.20	0.33	0.63			—	0.58				0.04	0.04	0.35	—	
Deer Park	0.10	—	0.50								0.01	—	—	—	
Elkins	0.32	0.92	0.51			0.14	—	0.77	0.01		0.08	0.05	0.26	0.06	
Aleppo						0.37	—	1.14	T						

STATION	March 1, 1903 Gage Height 28.9 ft					March 1, 1902 Gage Height 32.4 ft				
	26	27	28	1	2	26	27	28	1	2
Saegerstown		0.30	1.25	0.05				0.50	0.02	0.01
Erie		0.11	0.34	0.02				0.11	T	0.11
Franklin		1.23	0.58					0.79	T	
Oil City			1.30	0.08				0.51	0.51	0.07
Clarion			0.10	0.60				0.80	0.35	0.13
Warren		0.12	0.12					0.62	—	0.07
Parkers								0.39	0.22	0.06
St Marys								0.80	—	0.12
Ridgeway										
Brookville			0.92	0.24				1.35	—	0.16
Jamestown		0.04	0.63	0.05						
Indiana			0.80							
Freeport		0.50	0.79	0.07				0.36	0.29	0.17
Hawthorn							0.09	1.39	—	0.12
Saltsburg			0.96	0.10				0.40	0.24	0.15
Derry		0.56	0.88	0.05			T	0.51	0.17	0.45
Lycippus		0.95	0.10	T			0.42	0.12	0.24	0.15
Johnstown		0.70	0.64	0.05			0.05	0.71	0.11	0.46
Cassandra		0.80	0.18	0.10			0.04	0.65	0.02	0.05
Weston			1.32	0.12		0.54	T	0.63	0.07	0.01
Lost Creek										
Glenville			1.54	0.30		0.92	0.05	0.80	0.09	
Buckhannon		0.27	1.26	—						
Phillipi		0.30	1.07	0.02						
Clarksburg										
Rowlesburg			1.10	0.24		0.23	—	0.48	0.10	
Grafton		0.22	0.95	T		0.53	0.10	0.75	—	
Fairmont			1.18	0.34		0.57	0.01	0.77	0.21	
Parsons			2.00							
Pickens		0.53	0.77	0.21						
Terra Alta		T	2.00	0.10		0.80	—	—	0.90	
Morgantown		0.30	1.13	T		0.45	0.07	0.71	0.02	
Confluence						0.27	—	0.45	0.52	
Somerset	—	0.42	1.26	0.12		—	0.60	1.45	0.58	
Oakland										
Grantsville	0.00	1.10	0.86	0.20		0.15	0.80	—	0.54	—
Deer Park	0.00	0.16	0.75	0.20			1.10	—	0.05	—
Elkins		0.27	0.73	0.07		0.05	0.01	0.56		
Aleppo										

STATION	April 21, 1901 Gage Height 27.5 ft					November 27, 1900 Gage Height 27.7 ft					March 24, 1898 Gage Height 28.9 ft				
	18	19	20	21	22	24	25	26	27	28	21	22	23	24	25
Saegerstown															
Erie															
Franklin															
Oil City		0.75	2.00	0.43			1.20	0.87	0.58		0.28	0.39	1.42		
Clarion							1.23	1.14					2.03		
Warren		0.13	0.27	0.95			1.35	1.36	0.01						
Parkers		0.85	2.80	0.30		T	0.30	1.15	0.34		0.55	0.45	2.00		
St Marys															
Ridgeway													1.52		
Brookville		1.09	2.14	0.33		T	0.97	1.53	0.40		0.47	0.52	2.68	T	
Jamestown	0.31	0.80	1.65	0.24							0.20	0.45	0.40		
Indiana															
Freeport		1.00	2.43	0.41		0.14	0.84	1.44			0.49	0.45	2.53	0.23	
Hawthorn															
Saltsburg															
Derry															
Lycippus															
Johnstown		0.07	1.08	0.55			0.55	1.96	0.50		1.18	0.48	1.37	0.18	
Cassandra															
Weston		0.31	1.01	0.54		0.41	0.42	1.57	0.26		0.92	0.12	0.12	1.39	
Lost Creek															
Glenville		0.56	1.97	1.25		0.25	1.30								
Buckhannon		0.38	0.65	0.15											
Phillipi		0.40	0.74	0.13		0.10	0.45	2.02	0.40						
Clarksburg															
Rowlesburg		T	0.60	0.26		0.51	0.06	1.13	0.38		0.32	0.20	0.72	0.70	
Grafton		0.51	0.96	0.20		1.00	1.70								
Fairmont		1.70	0.56	0.15		0.47	0.42	1.72	0.24		1.20	0.40	0.40	1.00	
Parsons															
Pickens															
Terra Alta															
Morgantown		0.92	1.58	0.16											
Confluence		0.26	1.12	0.68		0.23	0.55	1.93	0.45		1.21	0.56	0.78	0.47	
Somerset															
Oakland															
Grantsville		0.50	1.09	0.55	0.20	0.50	0.67	1.63			1.10	0.70	0.46	0.70	
Deer Park		0.18	0.99	0.20	0.82	0.78	0.95	1.75			0.62	0.26	0.43	1.00	
Elkins		0.04	0.59	0.29		1.82	1.49								
Aleppo															

FLOOD COMMISSION,
PITTSBURGH, PA.

RAINFALL RECORDS

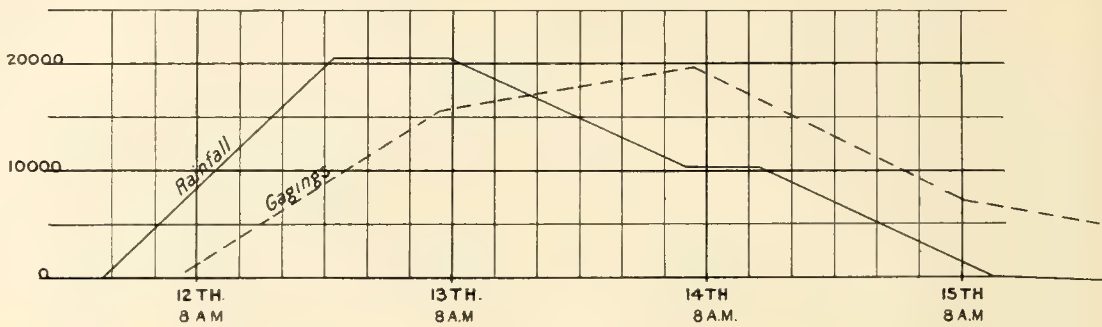
Indiana	Rain	Snow
1907 Mar 12th.	.50"	
" 13th.	1.30"	1.2"
" 14th	1.25"	
" 15th	.25"	

$\frac{.50}{.054}$ = 9 hours at same rate as 13th

$\frac{1.30}{24}$ = 0.54×.75 = .041(rain) + $\frac{1.2}{35}$ (snow) = .077 = 49.7(c.f.p.s per sq mile)×414 = 20600 c f p s

$\frac{1.25}{24}$ = 0.52×.75 = .039 = 25.16(" " " ")×414 = 10400 "

$\frac{.25}{0.52}$ = 5 hours at 10400

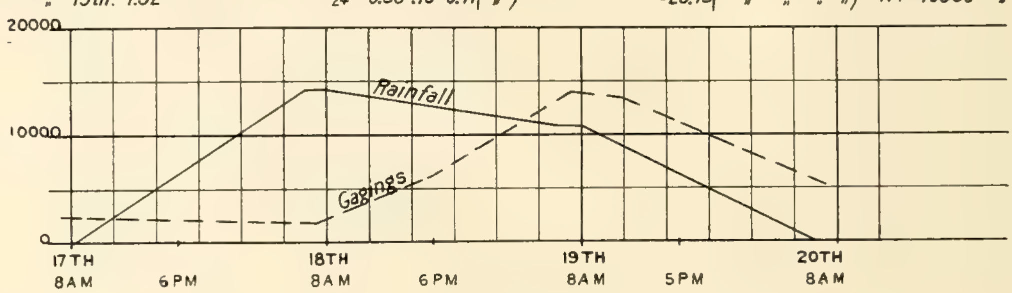


RAINFALL RECORDS

Indiana	Rain	Snow
1908 Mar. 18th	1.05"	.5"
" 19th.	1.32"	

$\frac{1.05}{24}$ = 0.44×.75=0.33(rain)+ $\frac{.5}{24}$(snow) = .054 = 34.84(c f p.s per sq. mi.)×414 = 14400 c.f.p.s.

$\frac{1.32}{24}$ = 0.55×.75=0.41(") = 26.45(" " " ")×414 = 10950 "



FLOOD COMMISSION

PITTSBURGH, PA.

DIAGRAM COMPARING

ACTUAL AND COMPUTED FLOOD CRESTS

BLACK LICK CREEK

DRAINAGE AREA ABOVE DAM 414 SQ. MI.

cent of the result, or 0.041 has been taken as the resulting run-off in inches per hour. Dividing the 0.50 inch of rainfall recorded on the 12th by the above hourly rate gives 9 hours of rainfall preceding 8 A. M. on the 12th. The equivalent of 1.2 inches of melted snow has been considered to have been on the ground at the beginning of this rainfall and to have melted and run off in the first 33 hours. This would give 0.036 inch of run-off per hour, or a total of 0.077 inch, which is equivalent to 49.7 cubic feet per second per square mile of drainage area. There are 414 square miles of drainage area above the dam, so that the total run-off above this point reached a maximum of 20,600 cubic feet per second. This began at zero, 9 hours preceding 8 A. M. on the 12th, and in 22 hours, the time of collection, reached the above maximum. It continued at this rate until 8 A. M. on the 13th, when it dropped in 22 hours to the run-off of 10,400 cubic feet per second, corresponding to the rainfall rate during the 24 hours preceding the 14th. It continued at this rate until 5 hours after 8 A. M. on the 14th, when it decreased to zero in 22 hours.

The dotted flood peak is constructed from actual discharges, using the Black Lick gage heights and rating table. It corresponds very closely in volume with the discharge estimated by means of the rainfall and snow and seems to have arrived 10 hours later than the estimated peak of the flood. A difference of this amount would naturally be expected, since the distribution of the rainfall throughout the 24 hours each day is not known.

The lower diagram shows a similar treatment of the flood of March 19, 1908, on Black Lick Creek. The dotted flood peak indicates the results taken from the Black Lick rating table, and compared with the peak estimated from the rainfall records, shows a very similar volume and shape, but a considerably later arrival. This is probably due to the fact that the rain registered on the morning of the 18th fell in the few hours preceding that time rather than throughout the whole 24 hours.

It would seem from the above that some of the tributary flood peaks as graphically constructed from the rainfall records may vary 10 to 20 hours from actual conditions of flow. This error, however, would not be in the same direction on different streams, and the combined result of the controlled tributaries under consideration would be practically the same. In other words, while it is true that, on account of this difference between actual and estimated conditions of flow, the flood waves of some streams doubtless occupy more effective positions under the Pittsburgh peak, yet in the same way there are other streams where the reverse is the case; so that the results, as estimated, are considered to be not far different from what would be obtained if it were possible to plot the flood wave of each stream in its exact position. In fact, an inspection of the diagrams by means of which the flood peak reductions have been obtained shows that the sum of the ordinates 20 hours on either side of the flood peak would be large enough to effect an equal reduction.

PEAK REDUCTION DIAGRAMS. 43 PROJECTS.

On the Peak Reduction Diagrams using all 43 projects, Plates 55 to 65, three reduced peaks are shown, one for each of the following conditions:

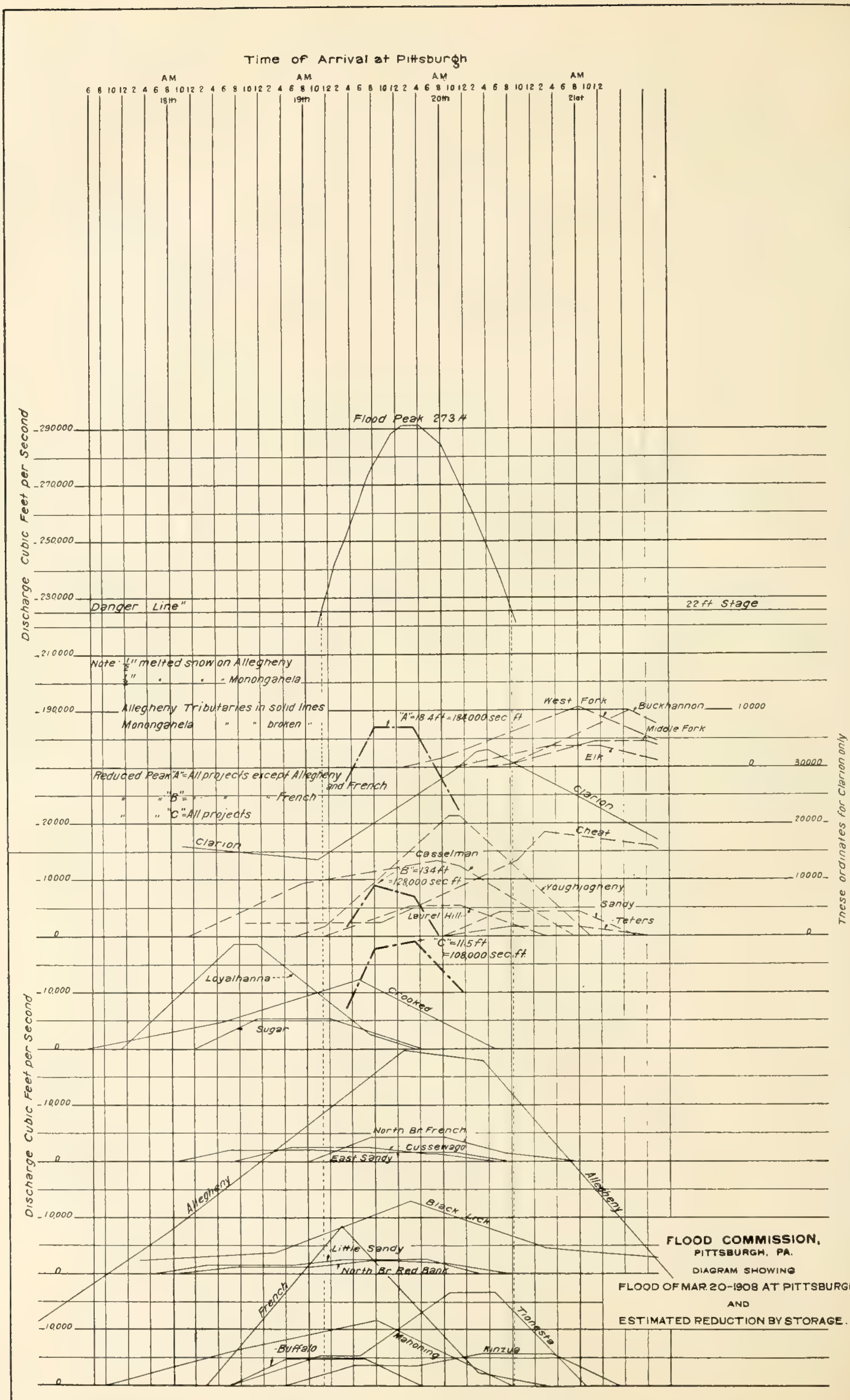
(A). Using all projects except the Allegheny and French.

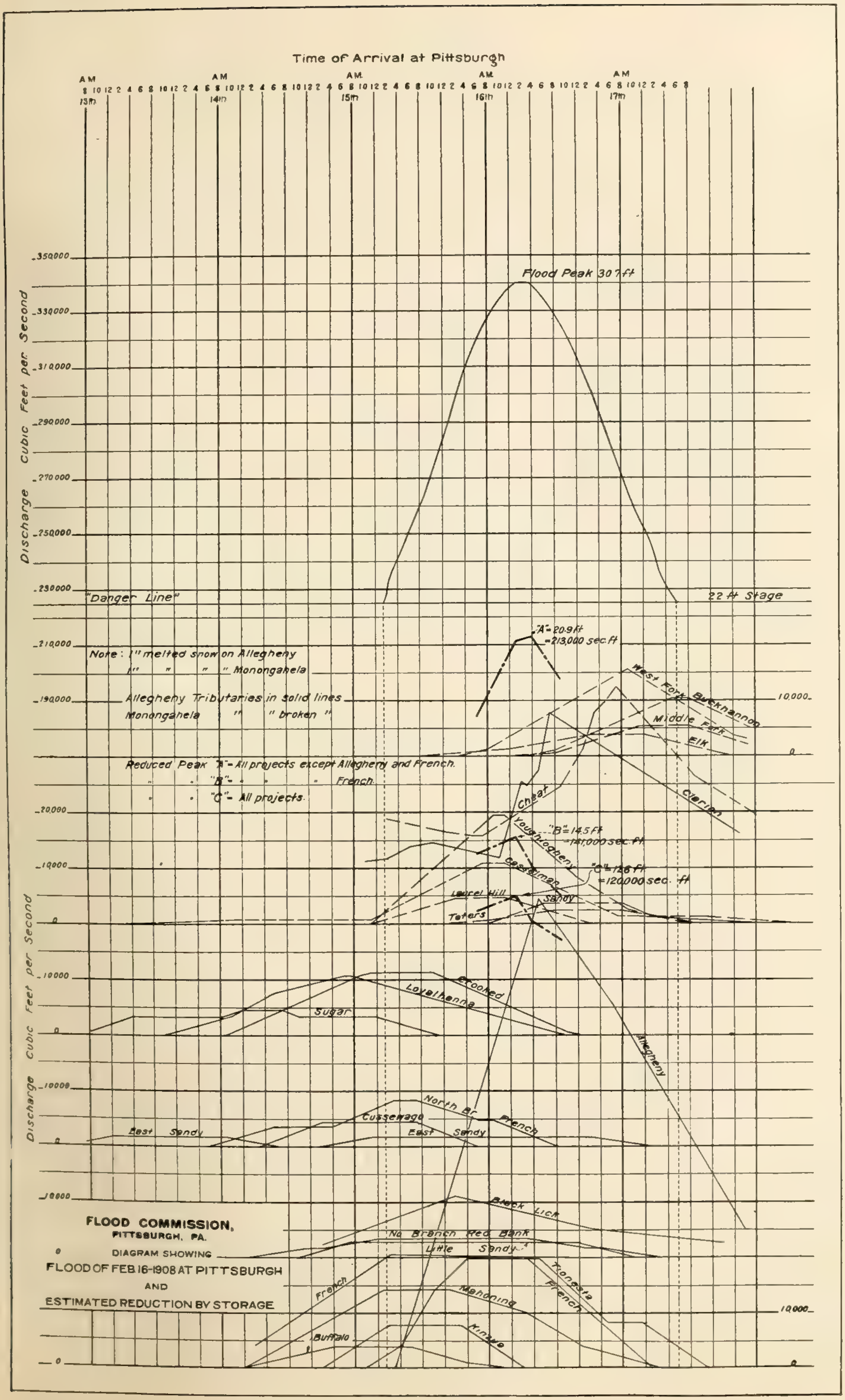
(B). Using all projects except the French.

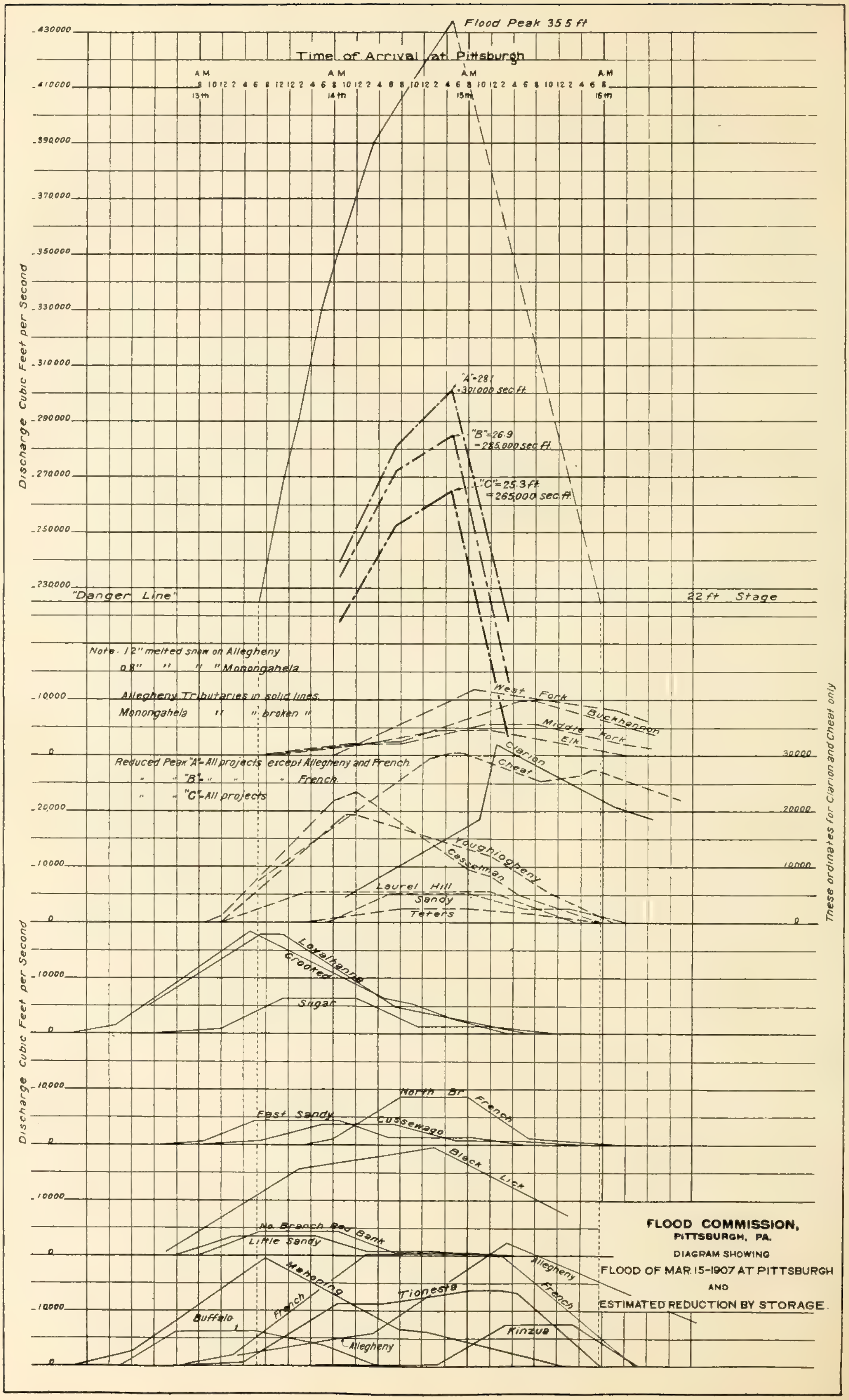
(C). Using all projects.

The eleven floods studied graphically by means of these diagrams have been analyzed and described as to their origins in a preceding chapter. From this discussion and from an inspection of the diagrams, it is evident that these floods present a wide varia-

PLATE 55


Time of Arrival at Pittsburgh
AM 18th
AM 19th
AM 20th
AM 21st
Discharge Cubic Feet per Second
Flood Peak 27.3 ft
"Danger Line"
22 ft Stage
Note: 1/2" melted snow on Allegheny
1/3" " " " Monongahela
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "A" = All projects except Allegheny and French
" " "B" = " " " French
" " "C" = All projects
"A" = 18.4 ft = 184,000 sec ft
"B" = 13.4 ft = 128,000 sec ft
"C" = 11.5 ft = 108,000 sec ft
These ordinates for Clarion only
West Fork
Buckhannon
Middle Fork
Elk
Clarion
Cheat
Casselman
Youghiogheny
Sandy
Teters
Laurel Hill
Loyalhanna
Crooked
Sugar
North Br French
Cussewago
East Sandy
Allegheny
Black Lick
Little Sandy
North Br Red Bank
French
Tionesta
Buffalo
Mahoning
Kinzua
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 20-1908 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.


Time of Arrival at Pittsburgh
13th
14th
15th
16th
17th
Discharge Cubic Feet per Second
Flood Peak 30.7 ft
"Danger Line"
22 ft Stage
"A"=20.9 ft =213,000 sec.ft
Note: 1" melted snow on Allegheny
1" " " " Monongahela
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "A" - All projects except Allegheny and French.
" " "B" - " " " French.
" " "C" - All projects.
"B"=14.5 ft =141,000 sec.ft
"C"=12.6 ft =120,000 sec. ft
West Fork
Buckhannon
Middle Fork
Elk
Clarion
Cheat
Youghiogheny
Cassleman
Laurel Hill
Sandy
Teters
Crooked
Loyalhanna
Sugar
Allegheny
North Br.
French
Cussewago
East Sandy
Black Lick
No. Branch Red Bank
Little Sandy
Tionesta
French
Mahoning
Buffalo
Kinzua
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF FEB.16-1908 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE



FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 15-1907 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.

PLATE 58

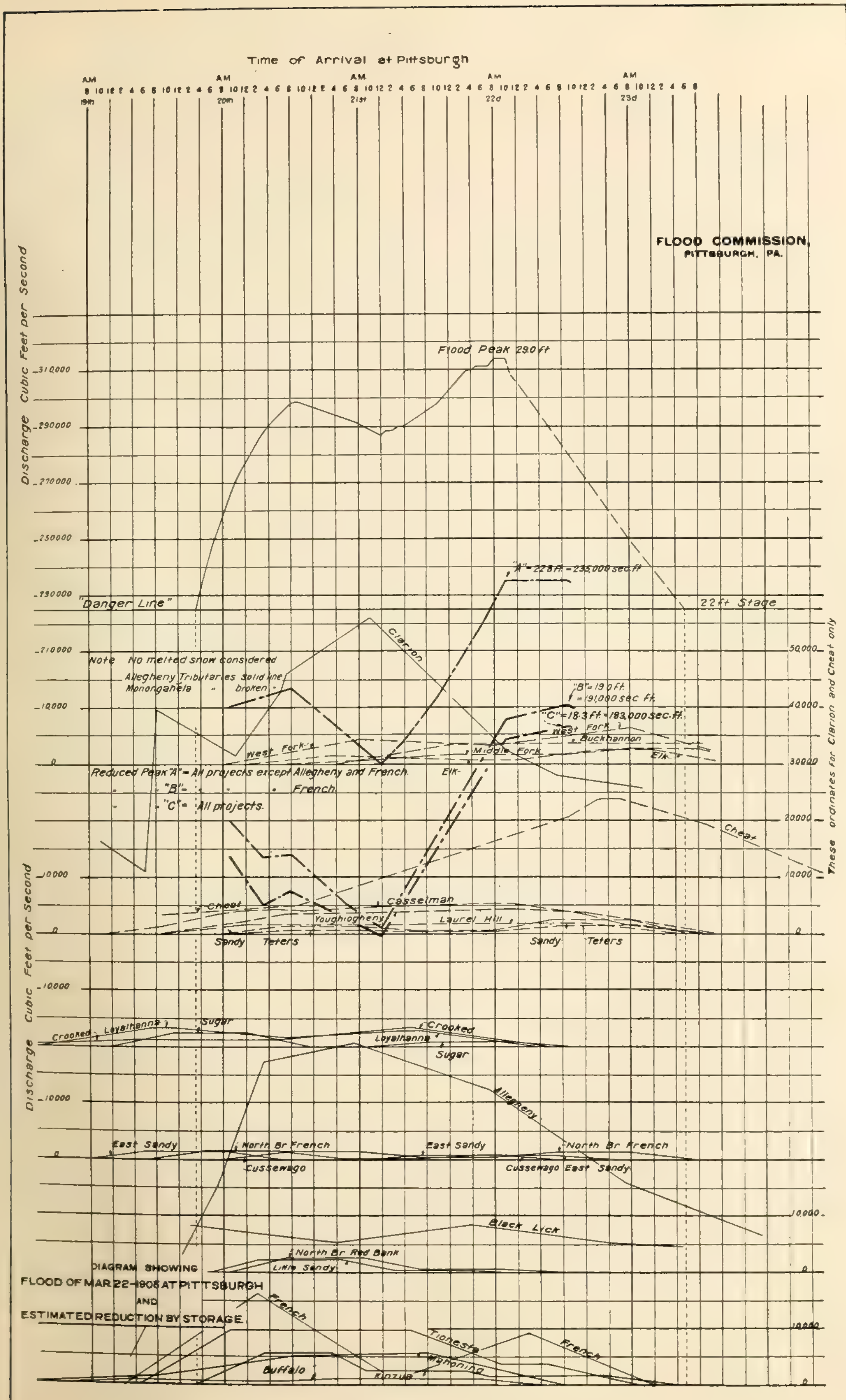
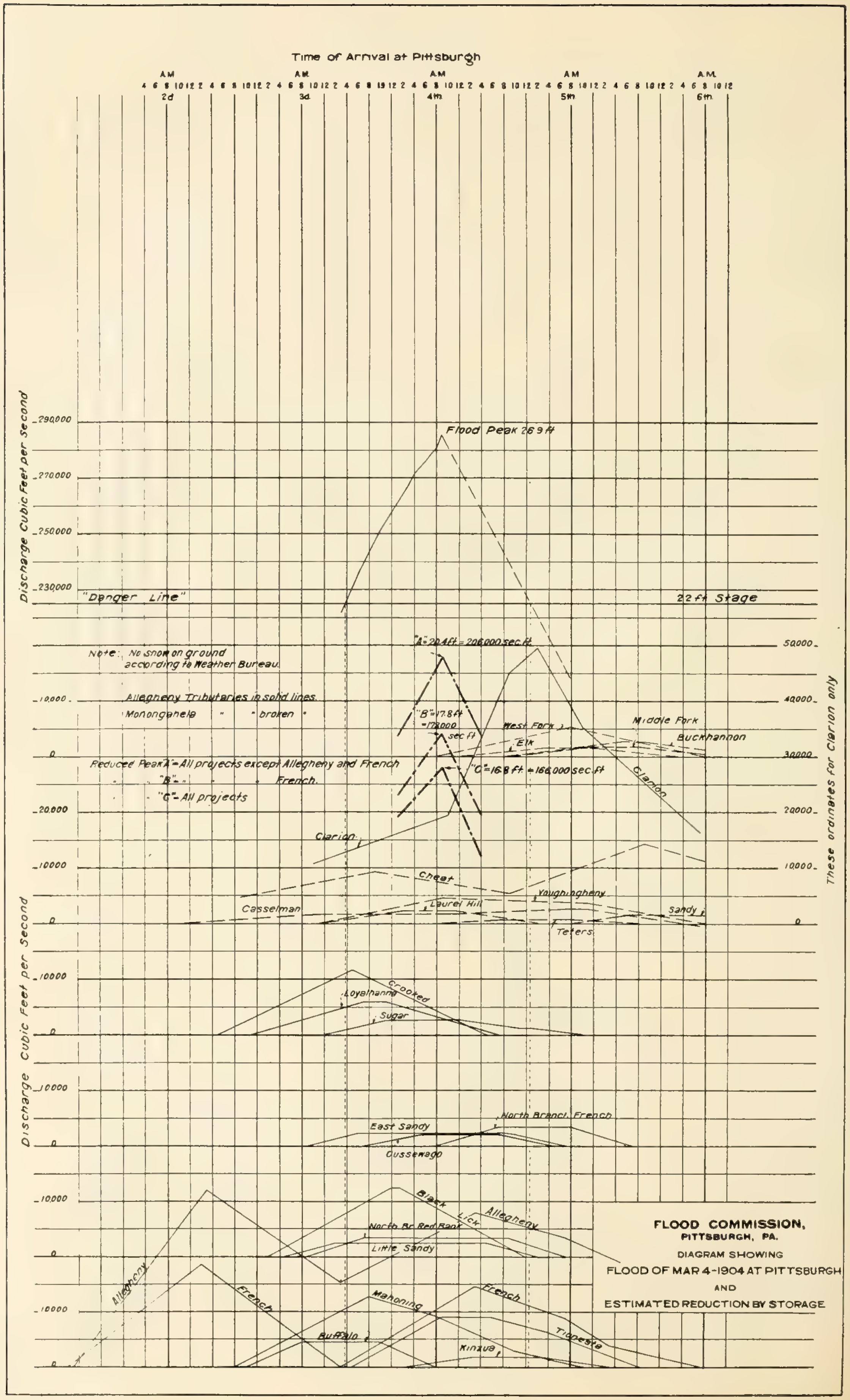
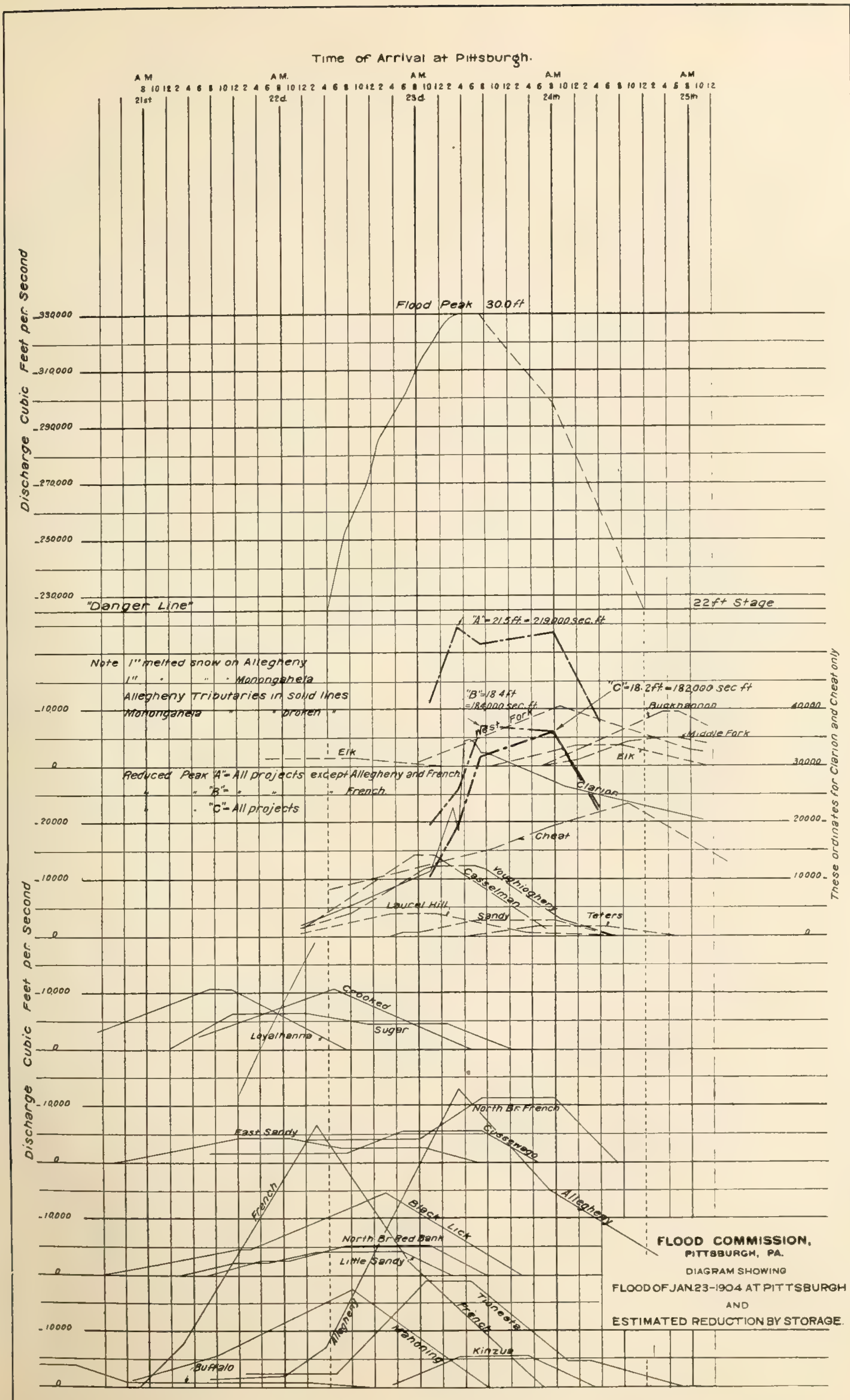


DIAGRAM SHOWING
FLOOD OF MAR 22-1905 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.



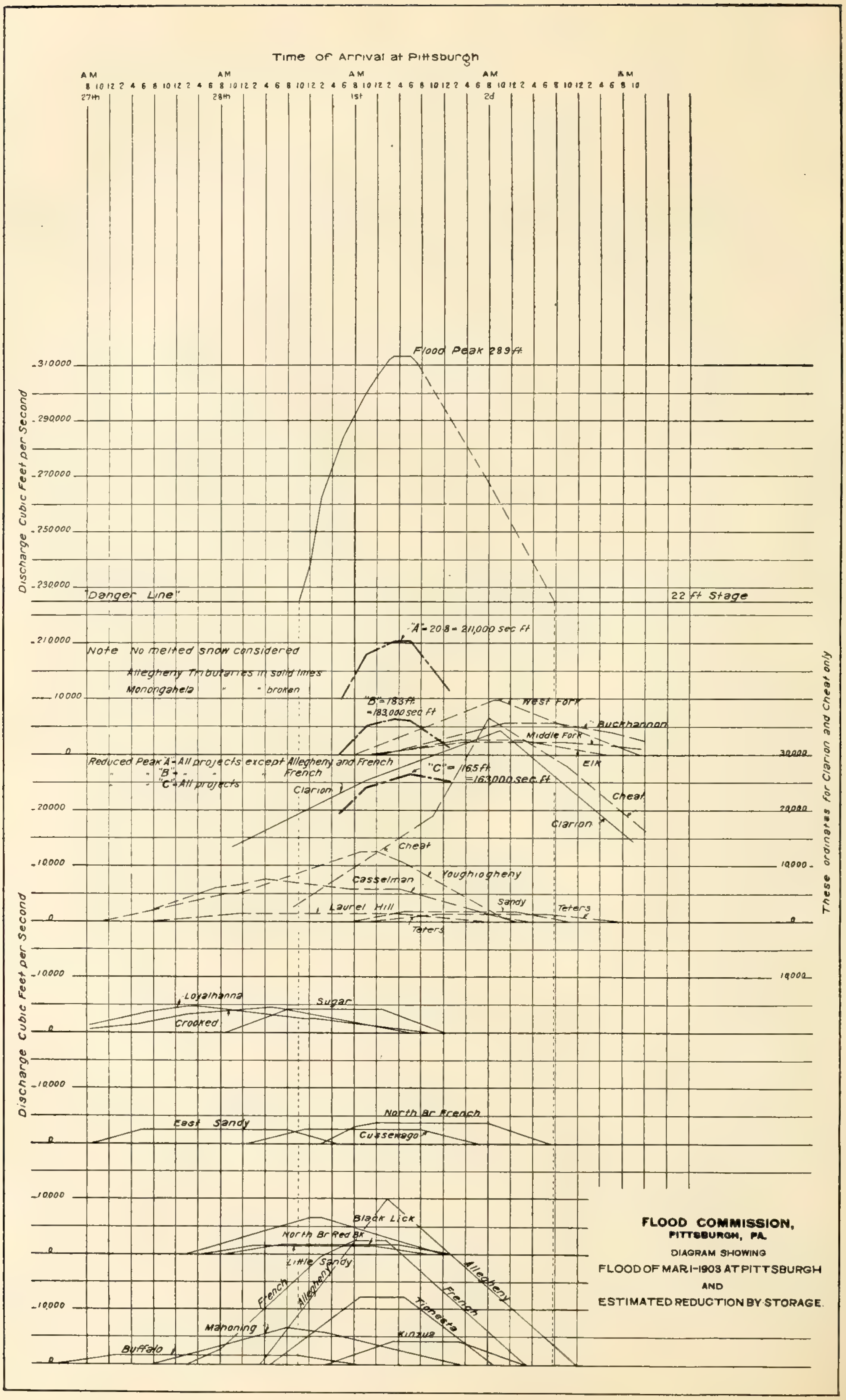
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR 4-1904 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE

PLATE 60



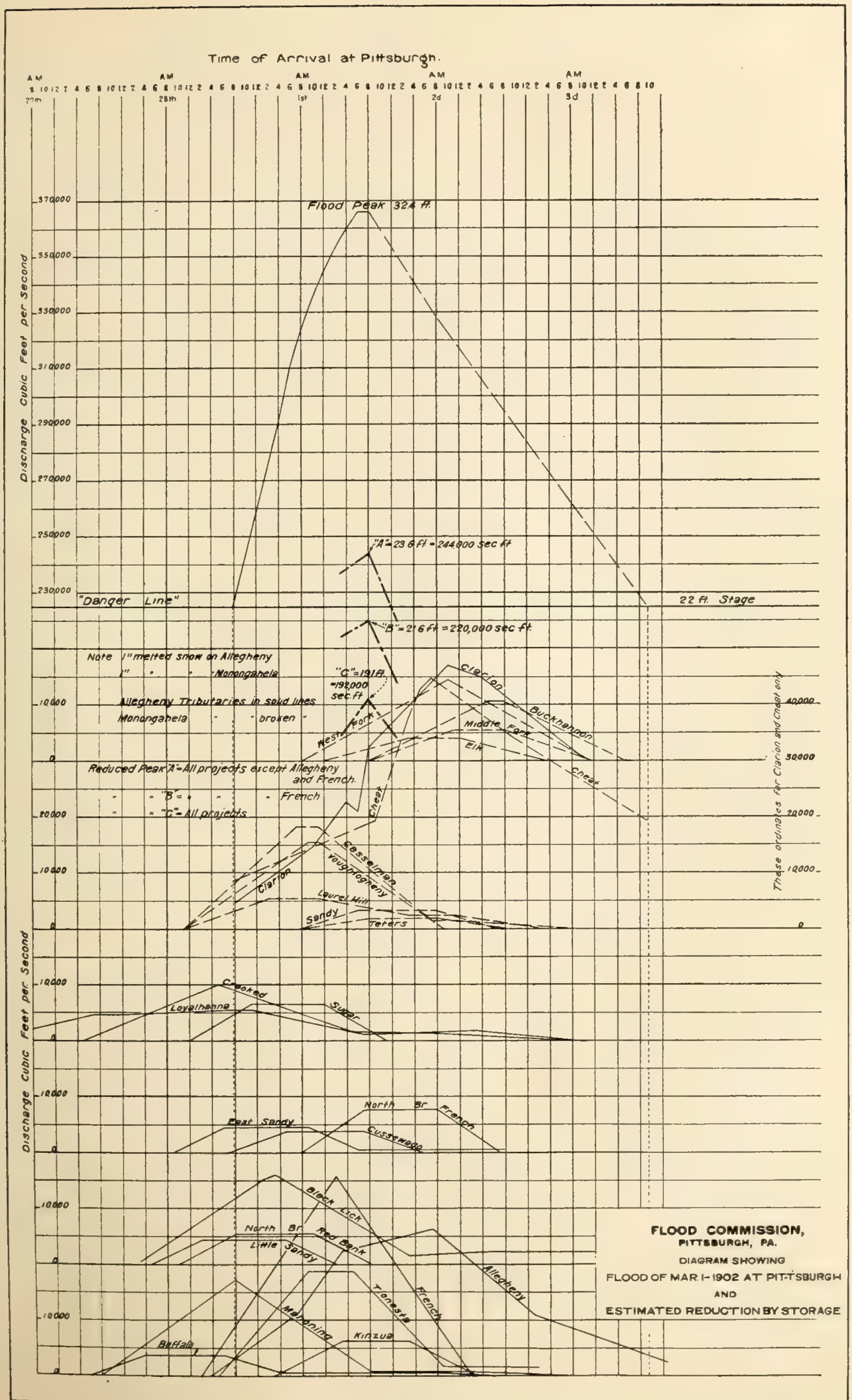
Time of Arrival at Pittsburgh.
Discharge Cubic Feet per Second
Flood Peak 30.0 ft
"Danger Line"
22 ft Stage
"A"=21.5 ft =219,000 sec. ft
"B"=18.4 ft =184,000 sec. ft
"C"=18.2 ft =182,000 sec ft
Note 1" melted snow on Allegheny
1" " " Monongahela
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "A"- All projects except Allegheny and French
" "B"- " " " French.
" "C"- All projects
These ordinates for Clarion and Cheat only
Elk
West Fork
Buckhannon
Middle Fork
Clarion
Cheat
Youghiogheny
Casselman
Laurel Hill
Sandy
Teters
Crooked
Sugar
Loyalhanna
North Br. French
East Sandy
Cussewago
Allegheny
French
Black Lick
North Br. Red Bank
Little Sandy
Tionesta
Mahoning
Kinzua
Buffalo
FLOOD COMMISSION.
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF JAN. 23-1904 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.

PLATE 61

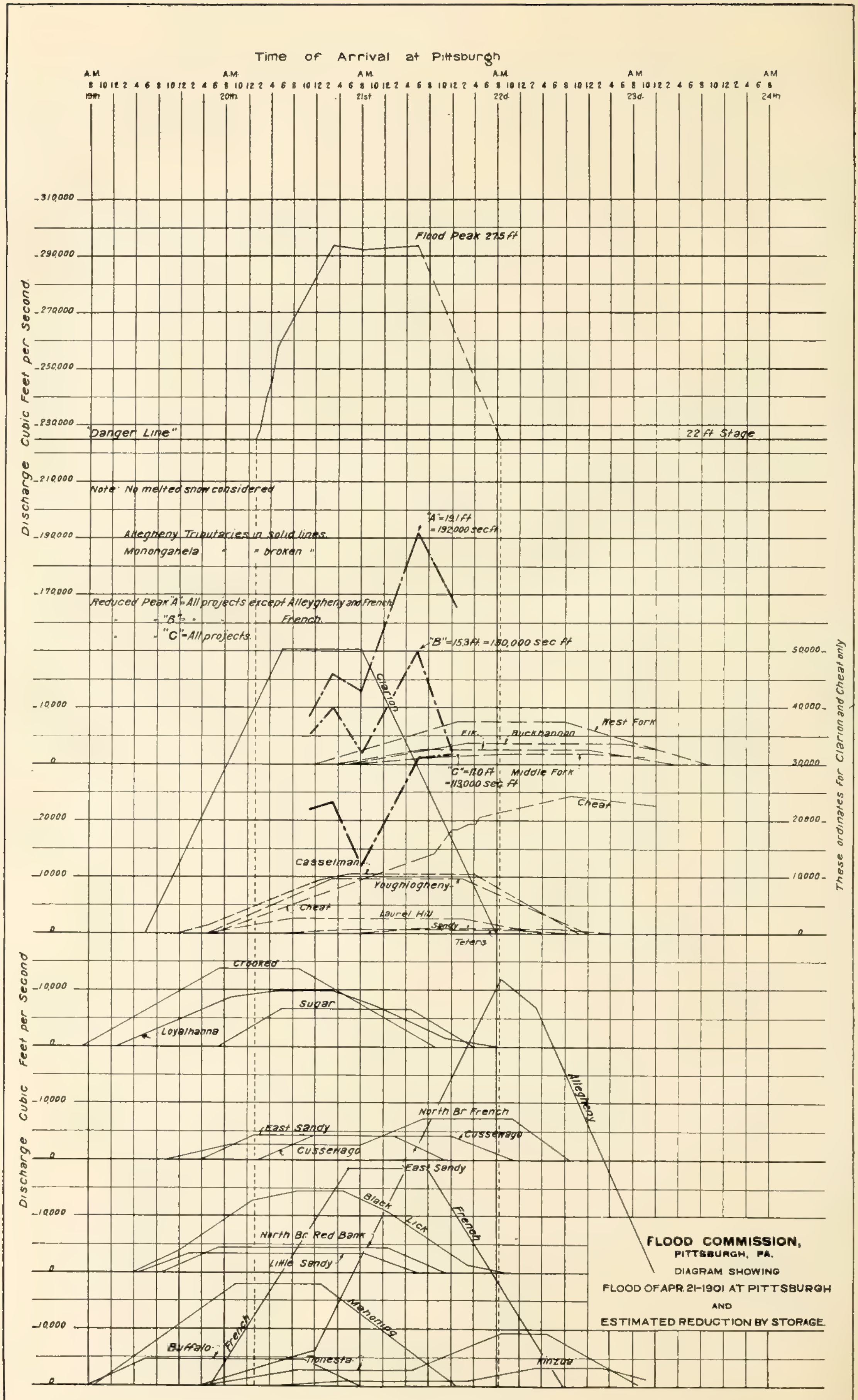


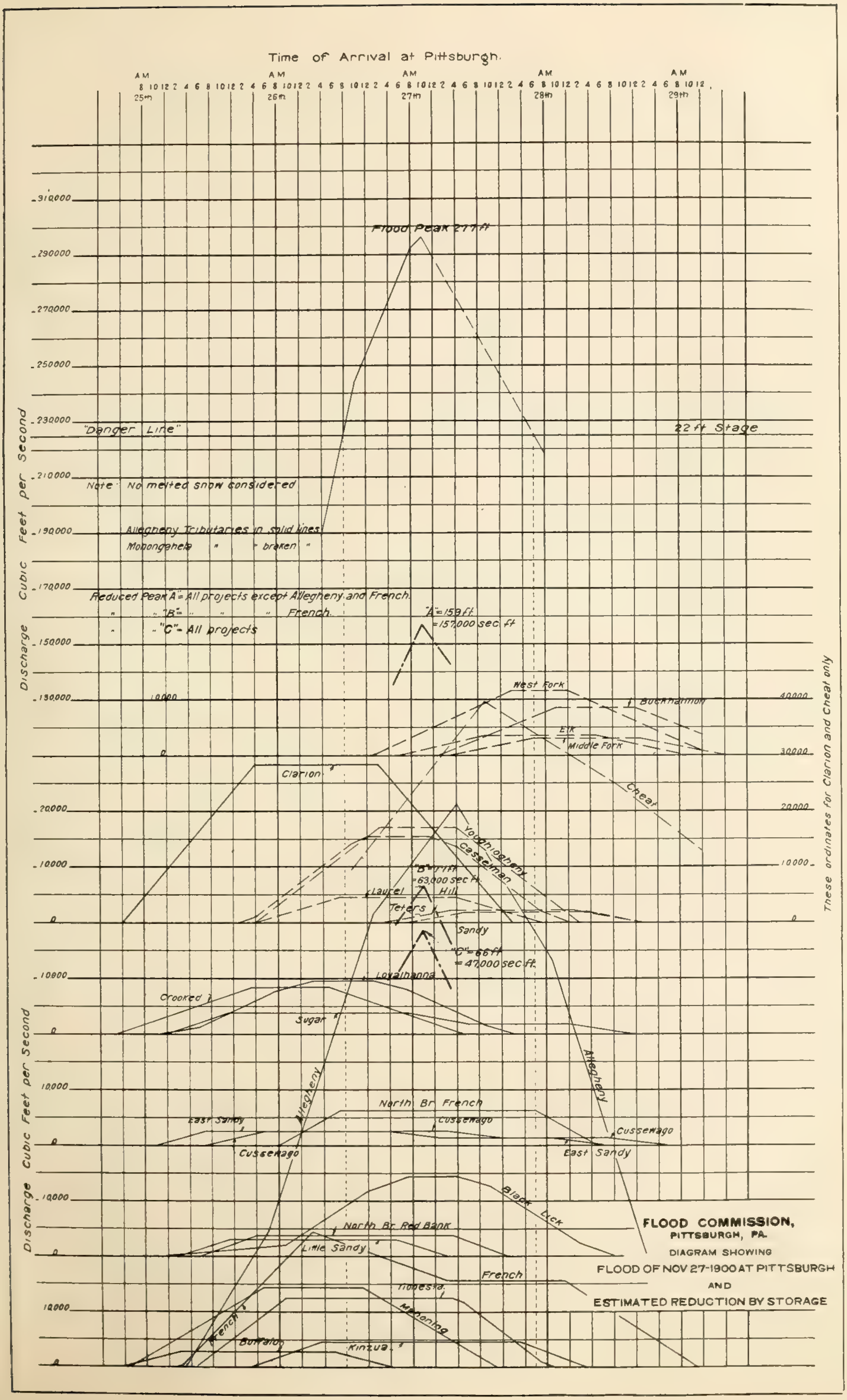
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR.1-1903 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.

PLATE 62



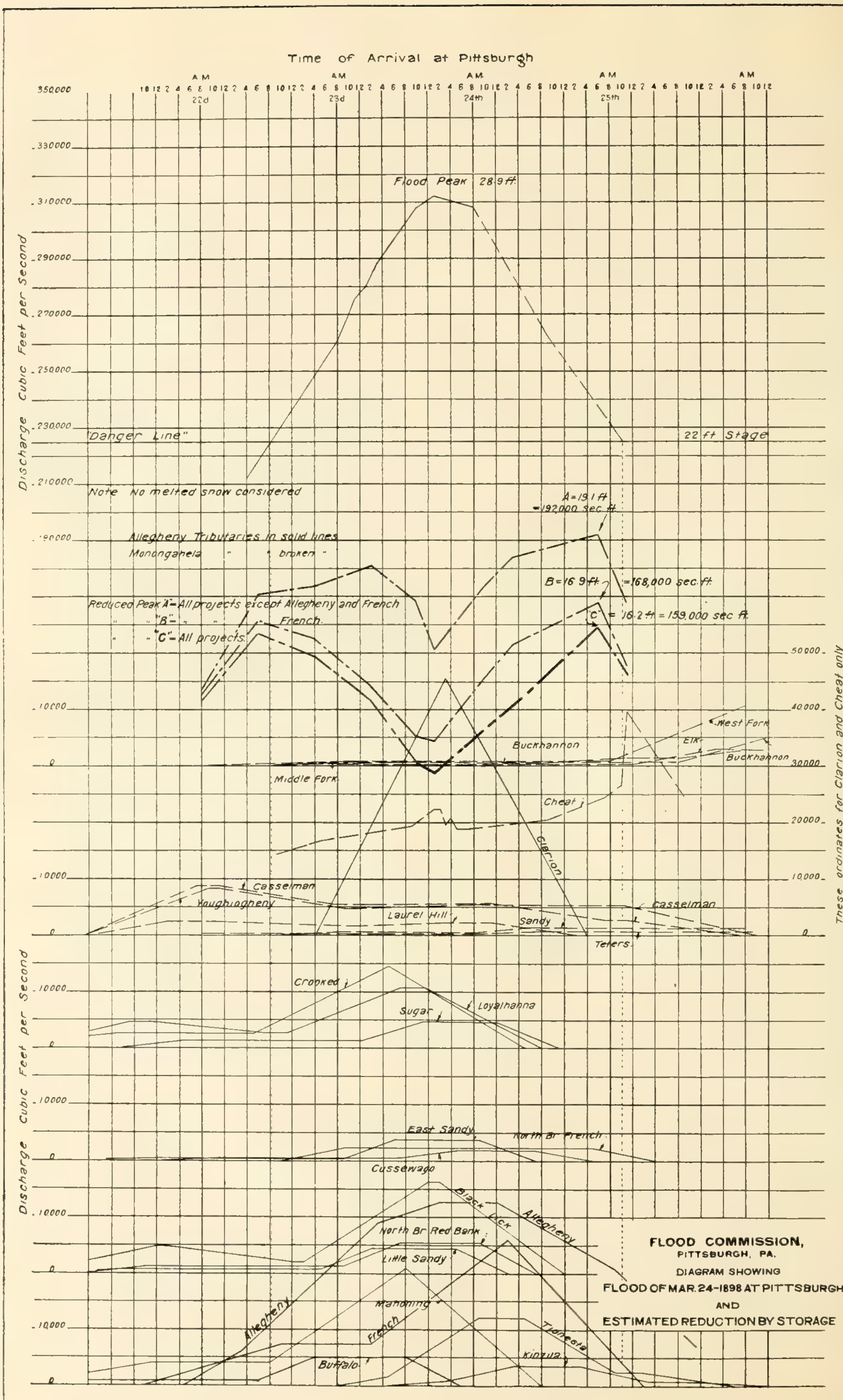
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 1-1902 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE


Time of Arrival at Pittsburgh
A.M.
19th
20th
21st
22d.
23d.
24th
Discharge Cubic Feet per Second.
Flood Peak 27.5 ft
"Danger Line"
22 ft Stage
Note: No melted snow considered
"A"=19.1 ft
=192,000 sec ft
Allegheny Tributaries in solid lines.
Monongahela " " broken "
Reduced Peak "A"=All projects except Alleygheny and French
" "B" " French.
"C"=All projects.
"B"=15.3 ft =150,000 Sec ft
"C"=11.0 ft
=113,000 sec ft
Clarion
Elk
Buckhannon
West Fork
Middle Fork
Cheat
Casselman
Youghiogheny
Laurel Hill
Sandy
Teters
These ordinates for Clarion and Cheat only
Crooked
Sugar
Loyalhanna
Allegheny
North Br French
East Sandy
Cussewago
Black Lick
French
North Br Red Bank
Little Sandy
Mahoning
Buffalo
Tionesta
Kinzua
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF APR. 21-1901 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.



FLOOD COMMISSION,
PITTSBURGH, PA.

DIAGRAM SHOWING
FLOOD OF NOV 27-1900 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE



FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 24-1898 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE

tion in the conditions affecting floods at Pittsburgh; and the diagrams may therefore be regarded as a fair test of the effect of the storage reservoirs in reducing Pittsburgh floods. A general summary of the results of this group of diagrams is given in Table No. 35.

This table shows that, of the eleven floods considered, all except the highest, that of March, 1907, would be reduced well below the "danger line" or 22-foot stage. The March, 1907, flood would be reduced to 25.3 feet, and would be above 22 feet for 22 hours as against the actual 61 hours. These eleven floods remained above the 22-foot level from 34 to 86 hours. The longest flood, that of March, 1905, which reached the gage height of 29 feet, remained above the 22-foot stage for 86 hours. This flood would be reduced to gage height 18.3 feet. This table also shows that with 62 per cent of the total drainage area controlled, a reduction of from 39 to 84 per cent of the peak discharge is obtained, or an average of 53 per cent.

STUDIES OF EFFECTIVENESS.

It is evident that estimates of flood reduction by reservoir control cannot be closely made on a percentage drainage area basis where the total drainage area above the point under consideration is as extensive and is subject to as many varying combinations of run-off as the area above Pittsburgh. With 50 per cent of the Allegheny Basin controlled by reservoir storage, for example, it can readily be understood that the discharge of the Allegheny at Pittsburgh in a particular flood might be reduced considerably more or much less than this percentage, according to the distribution of the rainfall and other factors affecting flood run-off. Thus, in the 1907 flood, when the rainfall on the upper Allegheny was so light and the upper tributaries were such small contributors to the Allegheny flood, 50 per cent of the drainage area under reservoir control, if located principally on these upper tributaries, would have effected considerably less than a 50 per cent reduction in the maximum discharge of the Allegheny at Pittsburgh; while if this percentage of area controlled had been located mainly in the southern part of the basin, particularly on the Kiskiminetas Basin, a reduction of much more than 50 per cent in the Allegheny flood discharge could have been obtained.

Moreover, it is not merely a matter of the magnitude of the flood in a controlled tributary, but just as much a question of how the contribution of that tributary arrives with reference to the time of the crest in the main river. Obviously, if a tributary has a considerable flood, but is so located that the time of collection and of travel of its flood water brings it to the mouth of the main river before or after the main flood crest, the control of such a tributary flood has a correspondingly small reducing effect on the main crest.

CONDITION FOR MAXIMUM EFFECTIVENESS.

In the Peak Reduction Diagrams it is evident that the condition of maximum effect on the Pittsburgh peak obtains when a tributary flood volume curve arrives with its greatest ordinate directly under the peak. Since the 22-foot stage is the "danger line," or stage at which a flood begins to do damage at Pittsburgh, it is also true, however, that any part of a tributary flood volume curve arriving at Pittsburgh during the time when the flood at that point is above 22 feet can be considered as representing damaging flood water. For this reason, and because, as already shown, the individual flood volume curves may actually arrive a number of hours before or after the positions in which they are plotted, equal credit for peak reduction has been given in the following analysis to all portions of the tributary flood volume curves coming within the effective zone, or period

TABLE No. 35.

FLOOD PREVENTION AT PITTSBURGH BY STORAGE RESERVOIRS.

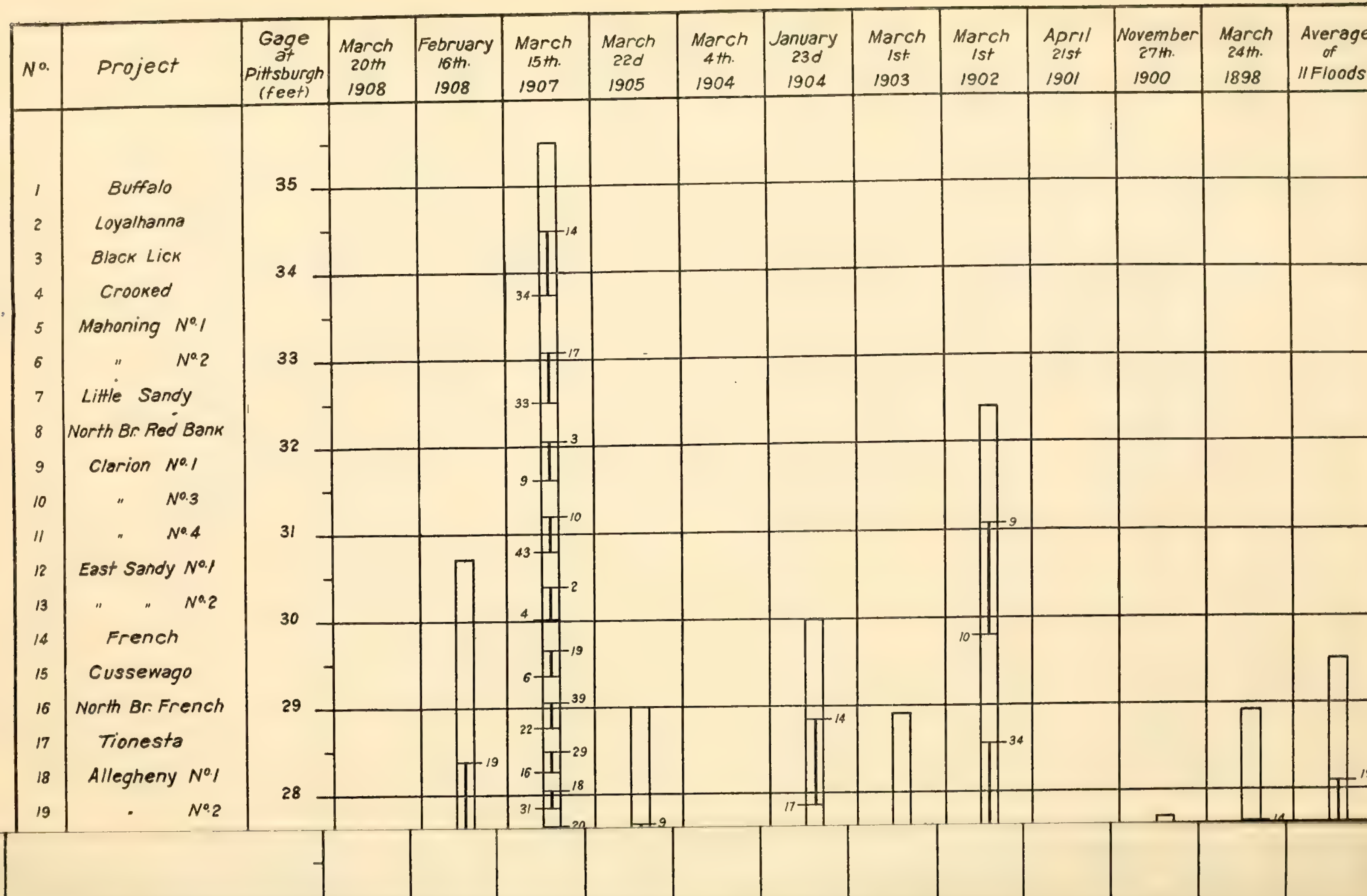
Flood	Without reservoirs		With all reservoirs except Allegheny and French		With all reservoirs except French		With all reservoirs		Without reservoirs		With all reservoirs	
	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Total discharge above 22-ft. stage	Total time above 22-ft. stage	Total time above 22-ft. stage	Reduction in flood discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Mill. cu. ft.*	*Hours*	*Hours*	*Per cent*
Mar. 20, 1908	27.3	292,000	18.4	184,000	13.4	128,000	11.5	108,000	5,000	33.5	00.0	63.0
Feb. 16, 1908	30.7	340,000	20.9	213,000	14.5	141,000	12.6	120,000	12,500	52.5	00.0	64.7
Mar. 15, 1907	35.5	434,000	28.1	301,000	26.9	285,000	25.3	265,000	25,800	60.5	22.0	*38.9
Mar. 22, 1905	29.0	315,000	22.8	235,000	19.0	191,000	18.3	183,000	17,800	86.0	00.0	41.9
Mar. 4, 1904	26.9	286,000	20.4	206,000	17.8	178,000	16.8	166,000	3,600	33.5	00.0	42.0
Jan. 23, 1904	30.0	330,000	21.5	219,000	18.4	184,000	18.2	182,000	13,000	56.0	00.0	44.8
Mar. 1, 1903	28.9	312,000	20.8	211,000	18.3	183,000	16.5	163,000	8,500	46.0	00.0	47.7
Mar. 1, 1902	32.4	366,000	23.6	244,000	21.6	220,000	19.1	192,000	19,700	73.0	00.0	47.5
Apr. 21, 1901	27.5	294,000	19.1	192,000	15.3	150,000	11.0	113,000	7,500	43.5	00.0	61.5
Nov. 27, 1900	27.7	296,000	15.9	157,000	7.7	63,000	6.6	47,000	4,500	34.0	00.0	84.1
Mar. 24, 1898	28.9	312,000	19.1	192,000	16.9	168,000	16.2	159,000	10,500	61.5	00.0	58.0
Average for 11 floods	29.5	320,000	21.0	214,000	17.3	172,000	15.6	153,000	11,670	52.7	2.0	52.7

CAPACITIES AND DRAINAGE AREAS.

With all reservoirs	Allegheny Basin	Monongahela Basin	Combined Basins
Reservoir capacity (flood control) mill. cu. ft.	49,725.8	30,772	80,497.8
Drainage area, total, sq. miles	11,580	7,340	18,920
Drainage area, controlled, sq. miles	8,454	3,379	11,833
Drainage area, controlled, per cent	73	46	62

*Low percentage due to light precipitation on upper Allegheny Basin.

PLATE 66



No.
Project
Gage at Pittsburgh (feet)
March 20th 1908
February 16th. 1908
March 15th. 1907
March 22d 1905
March 4th. 1904
January 23d 1904
March 1st 1903
March 1st 1902
April 21st 1901
November 27th. 1900
March 24th. 1898
Average of 11 Floods
1 Buffalo
2 Loyalhanna
3 Black Lick
4 Crooked
5 Mahoning No. 1
6 " No. 2
7 Little Sandy
8 North Br. Red Bank
9 Clarion No. 1
10 " No. 3
11 " No. 4
12 East Sandy No. 1
13 " " No. 2
14 French
15 Cussewago
16 North Br. French
17 Tionesta
18 Allegheny No. 1
19 " No. 2
35
34
33
32
31
30
29
28

TABLE No. 35.

FLOOD PREVENTION AT PITTSBURGH BY STORAGE RESERVOIRS.

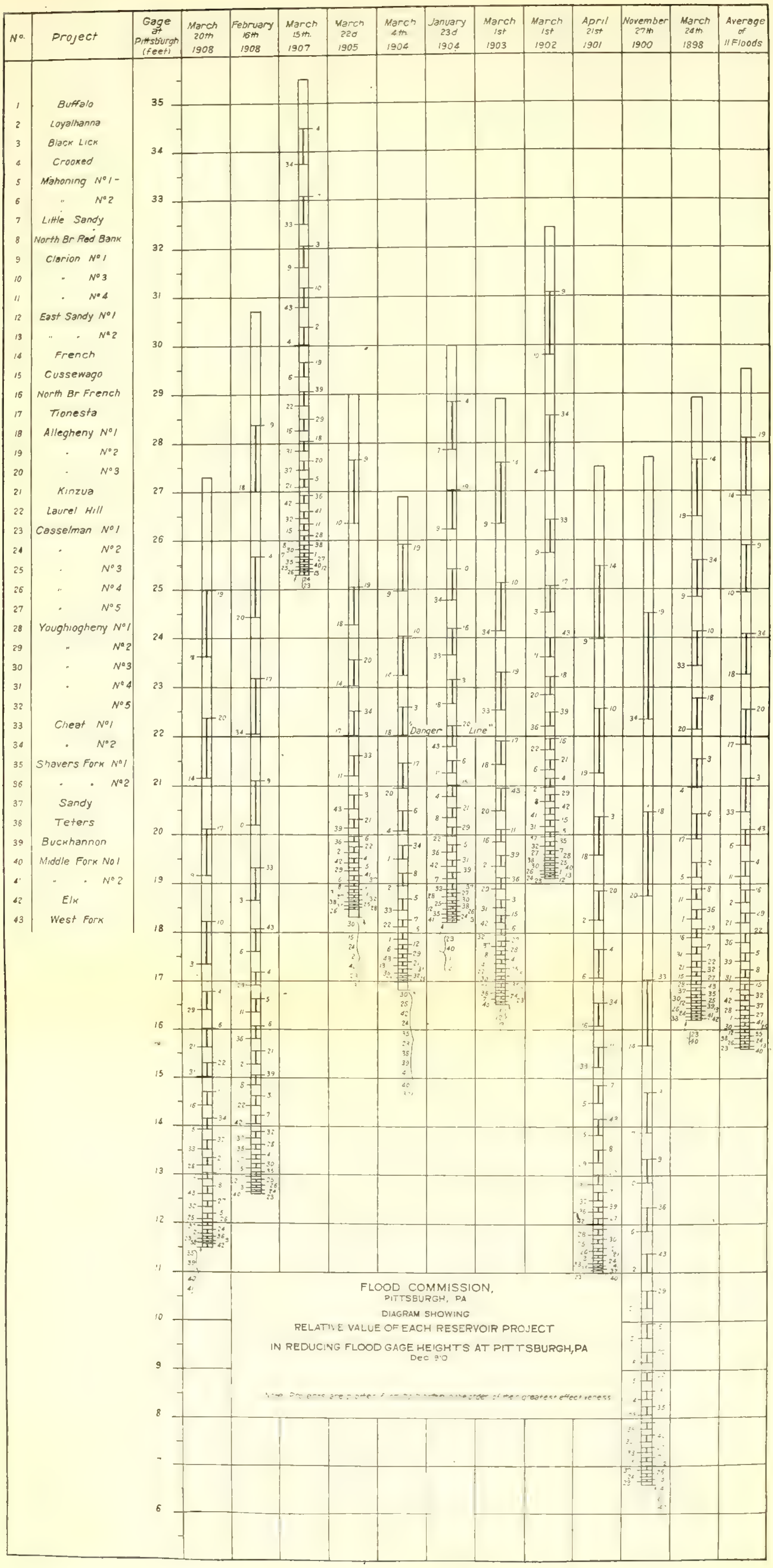
Flood	Without reservoirs		With all reservoirs except Allegheny and French		With all reservoirs except French		With all reservoirs		Without reservoirs		With all reservoirs	
	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Total discharge above 22-ft. stage	Total time above 22-ft. stage	Total time above 22-ft. stage	Reduction in flood discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Mill. cu. ft.*	*Hours*	*Hours*	*Per cent*
Mar. 20, 1908	27.3	292,000	18.4	184,000	13.4	128,000	11.5	108,000	5,000	33.5	00.0	63.0
Feb. 16, 1908	30.7	340,000	20.9	213,000	14.5	141,000	12.6	120,000	12,500	52.5	00.0	64.7
Mar. 15, 1907	35.5	434,000	28.1	301,000	26.9	285,000	25.3	265,000	25,800	60.5	22.0	*38.9
Mar. 22, 1905	29.0	315,000	22.8	235,000	19.0	191,000	18.3	183,000	17,800	86.0	00.0	41.9
Mar. 4, 1904	26.9	286,000	20.4	206,000	17.8	178,000	16.8	166,000	3,600	33.5	00.0	42.0
Jan. 23, 1904	30.0	330,000	21.5	219,000	18.4	184,000	18.2	182,000	13,000	56.0	00.0	44.8
Mar. 1, 1903	28.9	312,000	20.8	211,000	18.3	183,000	16.5	163,000	8,500	46.0	00.0	47.7
Mar. 1, 1902	32.4	366,000	23.6	244,000	21.6	220,000	19.1	192,000	19,700	73.0	00.0	47.5
Apr. 21, 1901	27.5	294,000	19.1	192,000	15.3	150,000	11.0	113,000	7,500	43.5	00.0	61.5
Nov. 27, 1900	27.7	296,000	15.9	157,000	7.7	63,000	6.6	47,000	4,500	34.0	00.0	84.1
Mar. 24, 1898	28.9	312,000	19.1	192,000	16.9	168,000	16.2	159,000	10,500	61.5	00.0	58.0
Average for 11 floods	29.5	320,000	21.0	214,000	17.3	172,000	15.6	153,000	11,670	52.7	2.0	52.7

CAPACITIES AND DRAINAGE AREAS.

With all reservoirs	Allegheny Basin	Monongahela Basin	Combined Basins
Reservoir capacity (flood control) mill. cu. ft.	49,725.8	30,772	80,497.8
Drainage area, total, sq. miles	11,580	7,340	18,920
Drainage area, controlled, sq. miles	8,454	3,379	11,833
Drainage area, controlled, per cent	73	46	62

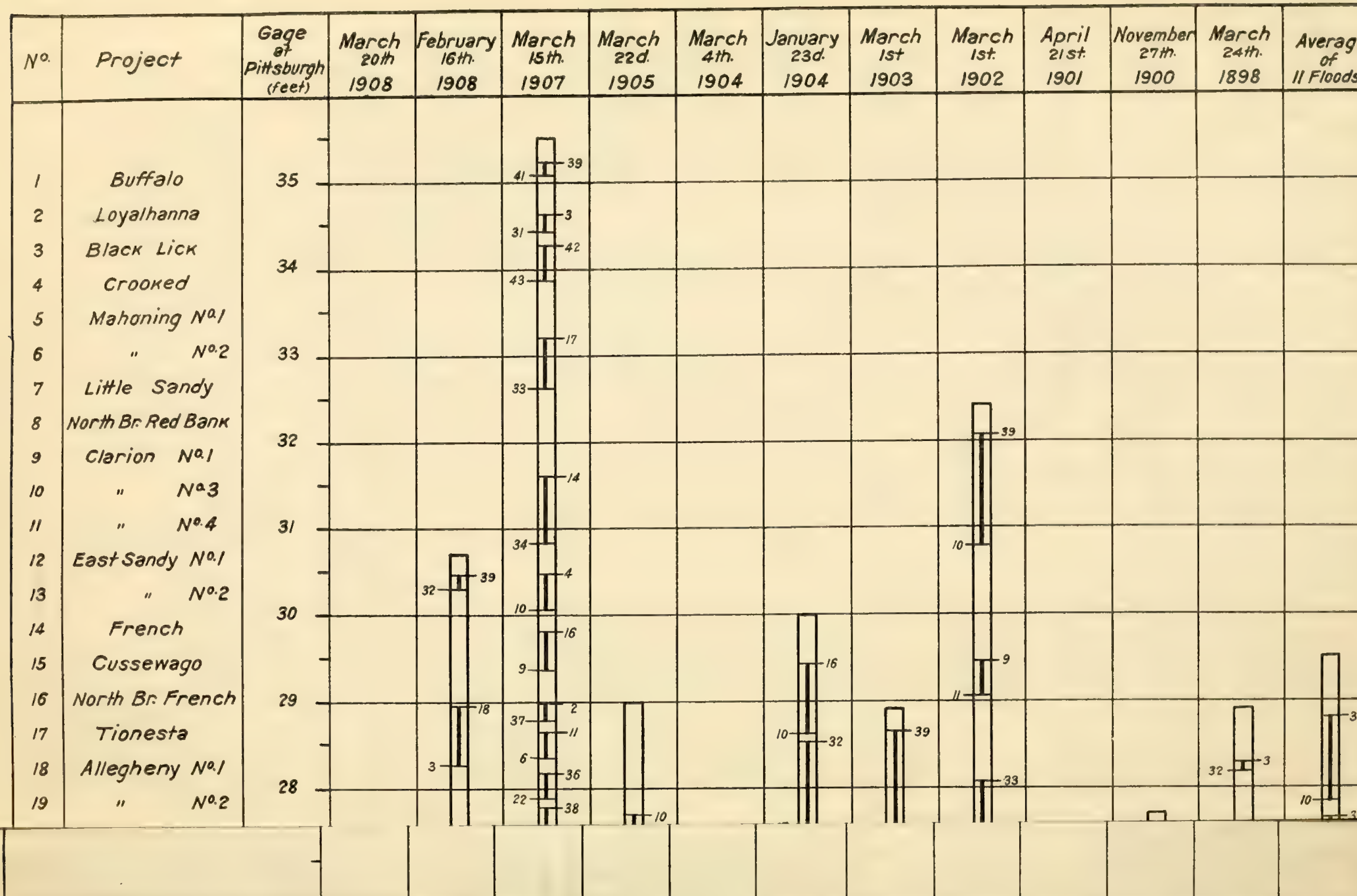
*Low percentage due to light precipitation on upper Allegheny Basin.

PLATE 66



No.
Project
Gage at Pittsburgh (feet)
March 20th 1908
February 16th 1908
March 15th 1907
March 22d 1905
March 4th 1904
January 23d 1904
March 1st 1903
March 1st 1902
April 21st 1901
November 27th 1900
March 24th 1898
Average of 11 Floods
1 Buffalo
2 Loyalhanna
3 Black Lick
4 Crooked
5 Mahoning No 1
6 " No 2
7 Little Sandy
8 North Br Red Bank
9 Clarion No 1
10 " No 3
11 " No 4
12 East Sandy No 1
13 " " No 2
14 French
15 Cussewago
16 North Br French
17 Tionesta
18 Allegheny No 1
19 " No 2
20 " No 3
21 Kinzua
22 Laurel Hill
23 Casselman No 1
24 " No 2
25 " No 3
26 " No 4
27 " No 5
28 Youghiogheny No 1
29 " No 2
30 " No 3
31 " No 4
32 No 5
33 Cheat No 1
34 " No 2
35 Shavers Fork No 1
36 " " No 2
37 Sandy
38 Teters
39 Buckhannon
40 Middle Fork No 1
41 " " No 2
42 Elk
43 West Fork
"Danger Line"
FLOOD COMMISSION,
PITTSBURGH, PA
DIAGRAM SHOWING
RELATIVE VALUE OF EACH RESERVOIR PROJECT
IN REDUCING FLOOD GAGE HEIGHTS AT PITTSBURGH, PA
Dec 1910

PLATE 67



No.
Project
Gage at Pittsburgh (feet)
March 20th 1908
February 16th. 1908
March 15th. 1907
March 22d. 1905
March 4th. 1904
January 23d. 1904
March 1st 1903
March 1st. 1902
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Average of 11 Floods
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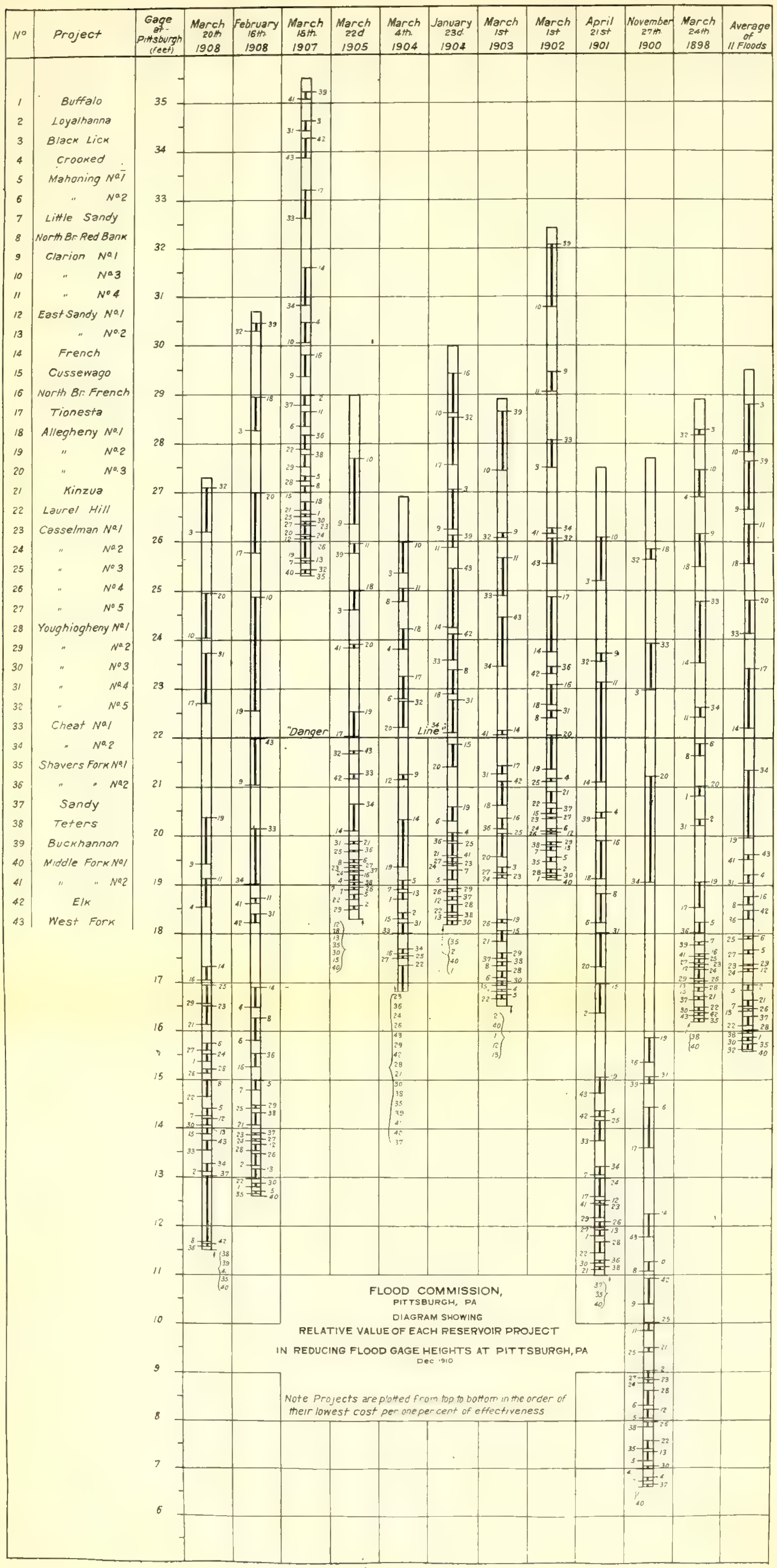
6 " No.2
7 Little Sandy
8 North Br. Red Bank
9 Clarion No.1
10 " No.3
11 " No.4
12 East Sandy No.1
13 " No.2
14 French
15 Cussewago
16 North Br. French
17 Tionesta
18 Allegheny No.1
19 " No.2
35
34
33
32
31
30
29
28

PLATE 67


No
Project
Gage at Pittsburgh (feet)
March 20th 1908
February 16th 1908
March 15th 1907
March 22d 1905
March 4th 1904
January 23d 1904
March 1st 1903
March 1st 1902
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November 27th 1900
March 24th 1898
Average of 11 Floods
1 Buffalo
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9 Clarion No 1
10 " No 3
11 " No 4
12 East Sandy No 1
13 " No 2
14 French
15 Cussewago
16 North Br. French
17 Tionesta
18 Allegheny No 1
19 " No 2
20 " No 3
21 Kinzua
22 Laurel Hill
23 Casselman No 1
24 " No 2
25 " No 3
26 " No 4
27 " No 5
28 Youghiogheny No 1
29 " No 2
30 " No 3
31 " No 4
32 " No 5
33 Cheat No 1
34 " No 2
35 Shavers Fork No 1
36 " " No 2
37 Sandy
38 Teters
39 Buckhannon
40 Middle Fork No 1
41 " " No 2
42 Elk
43 West Fork
"Danger Line"
FLOOD COMMISSION,
PITTSBURGH, PA
DIAGRAM SHOWING
RELATIVE VALUE OF EACH RESERVOIR PROJECT
IN REDUCING FLOOD GAGE HEIGHTS AT PITTSBURGH, PA
Dec 1910
Note Projects are plotted from top to bottom in the order of their lowest cost per one per cent of effectiveness

when the stage is above 22 feet. In consequence of this method of analysis, as will be seen later, the flood peak reductions obtained by summing up the respective portions credited to the 17 most effective projects give a somewhat less peak reduction in 7 out of 11 cases than is obtained on the special peak reduction diagrams constructed for those projects after their selection; and this in spite of the fact that in the former case the reservoirs are assumed to be always of sufficient capacity to store the entire flood waves of the respective tributaries, while in the latter, they are not considered effective beyond their capacity to dam crest, it being assumed that there is no regulation by means of the gates.

Inspection of the Peak Reduction Diagrams shows that certain tributaries are notable and repeated offenders in Pittsburgh floods, and it is obvious that the most effective storage will be that controlling their flood waters. The following discussion is intended to show the methods used in analyzing these diagrams and determining the most effective reservoir projects.

RELATIVE EFFECTIVENESS OF RESERVOIR PROJECTS.

From the Peak Reduction Diagrams, the effective volume of discharge for each project was obtained with a planimeter, and the relation of the effective volume of a given stream or project to the sum of all the effective volumes for that particular flood has been termed the "per cent of effectiveness." By "effective volume of discharge" is meant the volume or area on the Peak Reduction Diagrams included directly below the Pittsburgh flood peak, considering only that part above the "danger line" or 22-foot stage. The total reduction in flood peak in feet, with controlling reservoirs, was then multiplied by the per cent of effectiveness for a given stream or project, and the amount of peak reduction thus obtained credited to that project in the flood considered. This has been shown graphically on Plate 66. In this diagram the projects are plotted from top to bottom in the order of their effectiveness.

A study of the diagram indicates the variable distribution of rainfall at times of flood. For example, in the flood of March 20, 1908, Allegheny No. 2 project heads the column, while in the flood of March 15, 1907, it is the twelfth project from the top of the column. In the column showing average for the eleven floods, however, it again leads in effectiveness.

It is evident that, with the exception of the 1907 flood, a comparatively small number of reservoir projects is needed to reduce floods at Pittsburgh to below "danger line" or gage height 22 feet. The projects appearing regularly at the extreme bottom of the several columns are those which would have little effect in reducing floods at Pittsburgh, and should therefore be dismissed from further consideration.

RELATIVE COST PER UNIT OF EFFECTIVENESS.

It does not follow that because a reservoir has a low cost per million cubic feet of storage that it is the cheapest to build for flood control purposes. The flood water that it impounds may be that of a tributary which rarely, if ever, delivers that flood water at Pittsburgh during the critical time of flood. Whereas another reservoir, of high cost per unit of storage, may control a stream which is invariably an offender whenever its drainage area receives flood rainfall. A number of favorable sites have been selected and surveyed, and estimates of capacities and costs of the respective reservoirs have been determined. If only a certain number of them are to be built, the ultimate criterion for their selection is not lowest cost, nor even greatest effectiveness. It is both. In other words, the final selection should be based on lowest cost per unit of effectiveness. For the purpose of indicating the most desirable projects from this standpoint, there-

fore, the projects have been plotted in a similar manner on Plate 67. In this diagram the projects are plotted from top to bottom in the order of their lowest cost per one per cent of effectiveness.

The order of projects is considerably changed from that in the preceding diagram, but on closer study it will be found that thirteen out of the sixteen projects in the column of averages are the same. The projects regularly appearing at the bottom of the several columns are those of greatest cost for a given effectiveness and would naturally be eliminated in a further analysis as being too expensive to construct for flood prevention.

As an aid in further analysis and in the determination of which projects can best be omitted, the results of the two preceding diagrams have been tabulated in Table No. 36, which shows the relative importance of each project in each of the eleven floods considered in point of effectiveness and of lowest cost per unit of effectiveness.

TWENTY-EIGHT PROJECTS.

Upon analysis of this table and the two diagrams, 15 projects were thrown out. These are indicated by (*) in the diagram on Plate 68. In this diagram, in which the projects are arranged from top to bottom in order of effectiveness, the small decrease in flood gage height reduction by the elimination of the 15 projects is indicated by the length of the dotted section at the bottom of the several columns. The average reduction effected by these 15 projects is approximately only 0.8 foot, while the saving in cost, if they are omitted, is approximately $6,000,000, or 17.5 per cent of the total cost of all the projects considered.

SEVENTEEN SELECTED PROJECTS.

A further analysis of the problem reduced the number of reservoir projects needed for flood prevention to 17, as indicated in the diagram on Plate 69.

This diagram was made in the same general form as those previously shown. In this case, however, the projects are plotted to a scale of costs, and the diagram indicates that, with the expenditure of less than $22,000,000, the flood heights would be reduced to below the "danger line," gage height 22 feet, with the exception of the flood of 1907, which would be reduced to approximately 27.6 feet.

It is furthermore evident that, with an expenditure of about $16,000,000, a reduction of flood gage heights below the "danger line" would obtain, except in the 1907 and 1902 floods, where the reduction would be to gage heights of 28.9 and 22.5 feet respectively.

After eliminating the least desirable projects as above, it was necessary, of course, in the listing of the remaining projects in order of effectiveness, to revise the respective percentages of effectiveness given on the other diagrams, as the removal of one or more reservoir projects from a given stream generally increased the effectiveness of the remaining projects on that stream.

The more important features of the Seventeen Selected Projects are given in the table on Plate 69. As a general summary may be noted:

Total cost	$ 21,672,100
Total capacity, million cubic feet	59,481.4
Average cost, per million cubic feet	$364
Drainage area controlled, square miles	10,182
Drainage area controlled, per cent	53.8

In this table, under the general heading, "Relative Reduction in Gage Heights at

No.	PROJECT
1	Buffalo
2	Loyalhanna
3	Black Lick
4	Crooked
5	Mahoning No. 1
6	Mahoning No. 2
7	Little Sandy
8	North Branch Red Bank
9	Clarion No. 1
10	Clarion No. 3
11	Clarion No. 4
12	East Sandy No. 1
13	East Sandy No. 2
14	French
15	Cussewago
16	North Branch French
17	Tionesta
18	Allegheny No. 1
19	Allegheny No. 2
20	Allegheny No. 3
21	Kinzua
22	Laurel Hill
23	Casselman No. 1
24	Casselman No. 2
25	Casselman No. 3
26	Casselman No. 4
27	Casselman No. 5
28	Youghiogheny No. 1
29	Youghiogheny No. 2
30	Youghiogheny No. 3
31	Youghiogheny No. 4
32	Youghiogheny No. 5
33	Cheat No. 1
34	Cheat No. 2
35	Shavers Fork No. 1
36	Shavers Fork No. 2
37	Sandy
38	Teters
39	Buckhannon
40	Middle Fork No. 1
41	Middle Fork No. 2
42	Elk
43	West Fork

NOTE.—The numbers at the colu
heights at Pittsburgh. The figures in
to the order of the project in point of
For example:—In the eleven floo

fore, the projects have been plotted in a similar manner on Plate 67. In this diagram the projects are plotted from top to bottom in the order of their lowest cost per one per cent of effectiveness.

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Drainage area controlled, per cent	53.8

In this table, under the general heading, "Relative Reduction in Gage Heights at

TABLE No. 36.

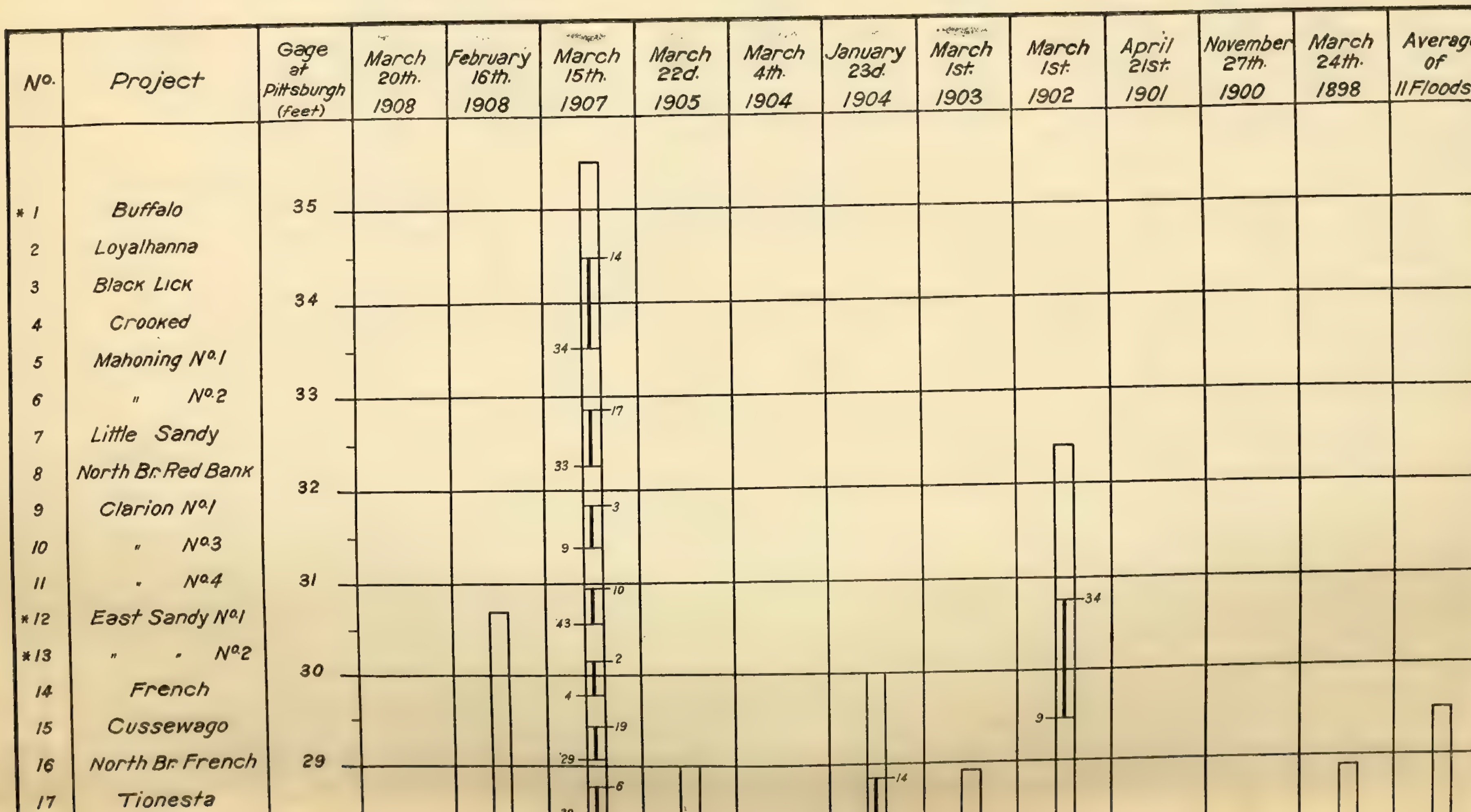
RELATIVE POSITION OF EACH PROJECT FOR FLOOD CONTROL.

No.	PROJECT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1	Buffalo														**1**				1 / **1**		1 / **1**			1						2 / **1**			**1**	1	**1**		1			1	**1**	1 / **1**	2 / **2**	**1**
2	Loyalhanna								1	1				1	2	**2**	**1**		1	**1**	2	1		**1**											**1**	1 / **1**	**1**			**2**		**1**		1
3	Black Lick	**1**	**3**	**1**	**2**	3 / **1**	**2**	1	2	2	1	1						1		**1**																								
4	Crooked				**1**		**1**	**1**		2	3 / **1**	**1**		1			1		**1**	2		**2**			1			1	**1**							**1**				**1**				
5	Mahoning No. 1														1	2 / **1**	1		1	**2**		3	1	**2**		**1**		1			**1**	1		**1**			**1**	**2**						
6	Mahoning No. 2								**1**	1	1	2 / **1**	2 / **1**	1		1		1 / **1**	1 / **1**		**2**	1 / **1**							**1**	**1**			**1**											
7	Little Sandy																**1**	1				1 / **1**		1	1 / **2**	1	1 / **1**	1		**1**	**1**	1		1	1		**2**		1		**2**			
8	North Branch Red Bank				**1**							**1**	**1**	1 / **1**		1	**1**		1 / **1**	1 / **1**	1		2 / **1**	**1**		1 / **1**	2				1 / **1**													
9	Clarion No. 1	2	3 / **1**	**3**	2	**1**	2 / **1**	1	**1**	1	**1**	**1**			**1**				**1**																									
10	Clarion No. 3	**3**	2 / **3**	3 / **1**	**1**	2		2 / **1**	1		1		**1**			**1**																												
11	Clarion No. 4			**2**	**1**	**2**			**1**	**1**	2 / **1**	1	1	1 / **1**	1	1	2	**1**			**1**							2																
12	East Sandy No. 1												**1**									1						**2**	**1**	**1**		**1**		1 / **1**	3 / **1**	1	**1**	**1**	1	1	1		1	1
13	East Sandy No. 2																	**1**									1			**1**			**1**	**1**		**2**	1	2 / **1**	**1**	2 / **2**	1	2		2 / **1**
14	French	5		1	3		2 / **1**		**1**	**2**	**1**	**1**	**1**	**2**			**1**	**1**																										
15	Cussewago															1 / **1**		**1**	1	2	**1**			1		1 / **1**	1 / **2**		1	1	**2**				1 / **1**				1			**1**	**1**	
16	North Branch French	**1**						1		**1**		**1**	3 / **1**	**1**		1 / **2**	2	1			1		1 / **1**	**1**	1 / **1**			**1**																
17	Tionesta		1	1	**1**	2	**2**	3 / **2**	2		**1**	**2**	1 / **1**			1			**1**								**1**																	
18	Allegheny No. 1	**1**	2	1 / **1**	1	**2**	2 / **1**	1	1		1 / **1**	1			**2**		**1**	1										**1**									**1**							
19	Allegheny No. 2	4	1	2	1	1	1	**2**	**1**	**1**		1			**1**			**2**		**1**	**1**			**1**															**1**					
20	Allegheny No. 3			1 / **1**	2	1 / **2**		1 / **1**	2		1 / **1**	1	1	**1**	**1**				**2**	**1**															**1**									
21	Kinzua												1	1	1		1 / **1**	2 / **1**		1		**1**	1	**1**	1 / **1**	1	**1**		**2**							1 / **1**	**1**				**1**			
22	Laurel Hill													1	1		1	1	1	1	1 / **1**	1		1	1 / **2**			**1**			1			**1**	**1**		**2**	**1**	**2**					
23	Casselman No. 1															**1**						**1**			**1**	**1**		**2**	**2**	**1**	**1**			**1**			1		1	1	2	1	4	1
24	Casselman No. 2																			**1**			**1**			**1**	**2**		**1**	**1**	**2**		**1**	1		**1**	1	2	2	1	1	1	1	1
25	Casselman No. 3													**1**				**1**			**1**	**1**	**2**	**1**		**2**	**1**				1 / **1**		3	2	1	1		1	1					
26	Casselman No. 4																						**1**		**1**							1 / **5**	**2**		3	1 / **1**	2	1 / **1**	1	1	1			
27	Casselman No. 5																		**1**		**1**			1 / **1**	**1**		**3**	3 / **1**		1	2	1 / **1**	2 / **2**			1								
28	Youghiogheny No. 1																					**1**	1		**1**	1	1	**1**	1	2	2	1 / **1**		1 / **1**	**1**	1 / **3**			**1**		**1**			
29	Youghiogheny No. 2										1				1 / **1**	2	1			2 / **1**	1	1	1 / **1**	1		**1**		**1**			**2**	**1**		**2**			**1**							
30	Youghiogheny No. 3																											1	1 / **1**		1	2 / **1**	3	2 / **1**			1	1 / **2**	**2**	**2**		**2**		
31	Youghiogheny No. 4				**1**	**1**				**1**			**1**	**1**	1	**2**	**1**	**1**	3 / **1**			**1**	2	2			1	1	1															
32	Youghiogheny No. 5	**1**	**3**	**1**	**2**					**2**			**1**							1		1	1		1	1	1	1	1	1	1	1										**1**		
33	Cheat No. 1			**1**	1	2 / **1**	2 / **1**	**1**	1 / **1**	2		**1**	**1**	**1**	1	1					1		**2**										**1**											
34	Cheat No. 2		2	2	1		2 / **1**	1 / **1**		**1**	**1**	2	**1**			**1**	**1**	1						**2**										**1**										
35	Shavers Fork No. 1																									1				1		1		1	1 / **2**	1	2	1	**1**	1 / **1**	1 / **2**	**1**	**3**	**1**
36	Shavers Fork No. 2								**1**			1		**1**	1	1	1 / **1**	1	1	**2**	**1**	**1**	1 / **1**	1			1		1	**1**						1		**1**	**1**					
37	Sandy																**1**				1	1		1	1	1 / **2**		1	2 / **1**	**1**	1		1	**1**		**1**	1 / **1**				1	**2**		1 / **1**
38	Teters																					**1**						**1**		**2**	1	1	2 / **1**	1	1 / **1**		1	1 / **1**	1 / **1**	1 / **2**	1		**1**	
39	Buckhannon	4			**1**			**1**	**1**		**1**			3	1							1	**1**			2			1							1					1 / **2**	1		
40	Middle Fork No. 1																																					2			1 / **1**	2	3 / **3**	3 / **7**
41	Middle Fork No. 2		**1**						**2**		**1**				**1**									1	1 / **1**	1 / **1**			1 / **1**			1							2 / **1**	1		2 / **2**		1
42	Elk					**1**						**1**		**1**	**2**		**1**	**1**			2 / **1**			1	2		1		1	1					**1**	1		**1**		1 / **1**		1		
43	West Fork						**1**	**1**	1	2 / **2**	**1**	1 / **1**	2	1	**1**			1	**1**						1		1			1		**1**	**1**								**1**			

NOTE.—The numbers at the column headings (1 to 43) indicate the order of the respective projects from top to bottom in the diagrams showing relative value of each reservoir project in reducing flood gage heights at Pittsburgh. The figures in the spaces to the right of the respective projects indicate the number of times that the project occupies the position indicated by the column heading, the upper figure referring to the order of the project in point of effectiveness and the lower figure, (in black type), referring to the order of the project in point of lowest cost per one per cent of effectiveness.

For example:—In the eleven floods, Allegheny No. 1, in point of effectiveness, was 2nd twice, 3rd once, 4th once, 6th twice, 7th once, 8th once, 10th once, 11th once and 17th once.

PLATE 68


No.
Project
Gage at Pittsburgh (feet)
March 20th. 1908
February 16th. 1908
March 15th. 1907
March 22d. 1905
March 4th. 1904
January 23d. 1904
March 1st. 1903
March 1st. 1902
April 21st. 1901
November 27th. 1900
March 24th. 1898
Average of 11 Floods
* 1 Buffalo
2 Loyalhanna
3 Black Lick
4 Crooked
5 Mahoning No. 1
6 " No. 2
7 Little Sandy
8 North Br. Red Bank
9 Clarion No. 1
10 " No. 3
11 " No. 4
* 12 East Sandy No. 1
* 13 " " No. 2
14 French
15 Cussewago
16 North Br. French
17 Tionesta
35
34
33
32
31
30
29
14
34
17
33
3
9
10
43
2
4
19
29
6
34
9
14

[illegible]

[illegible]

PLATE 68

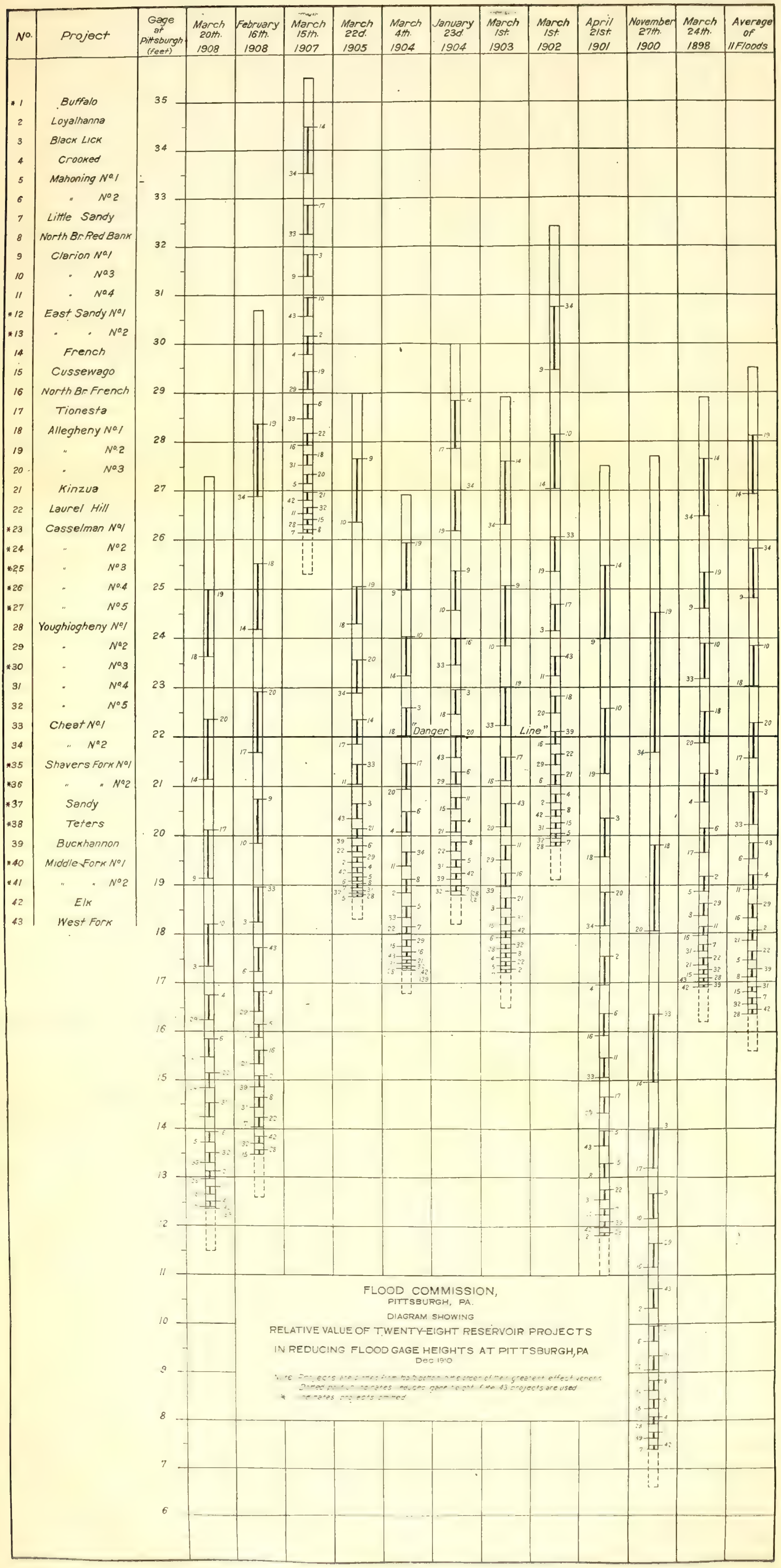
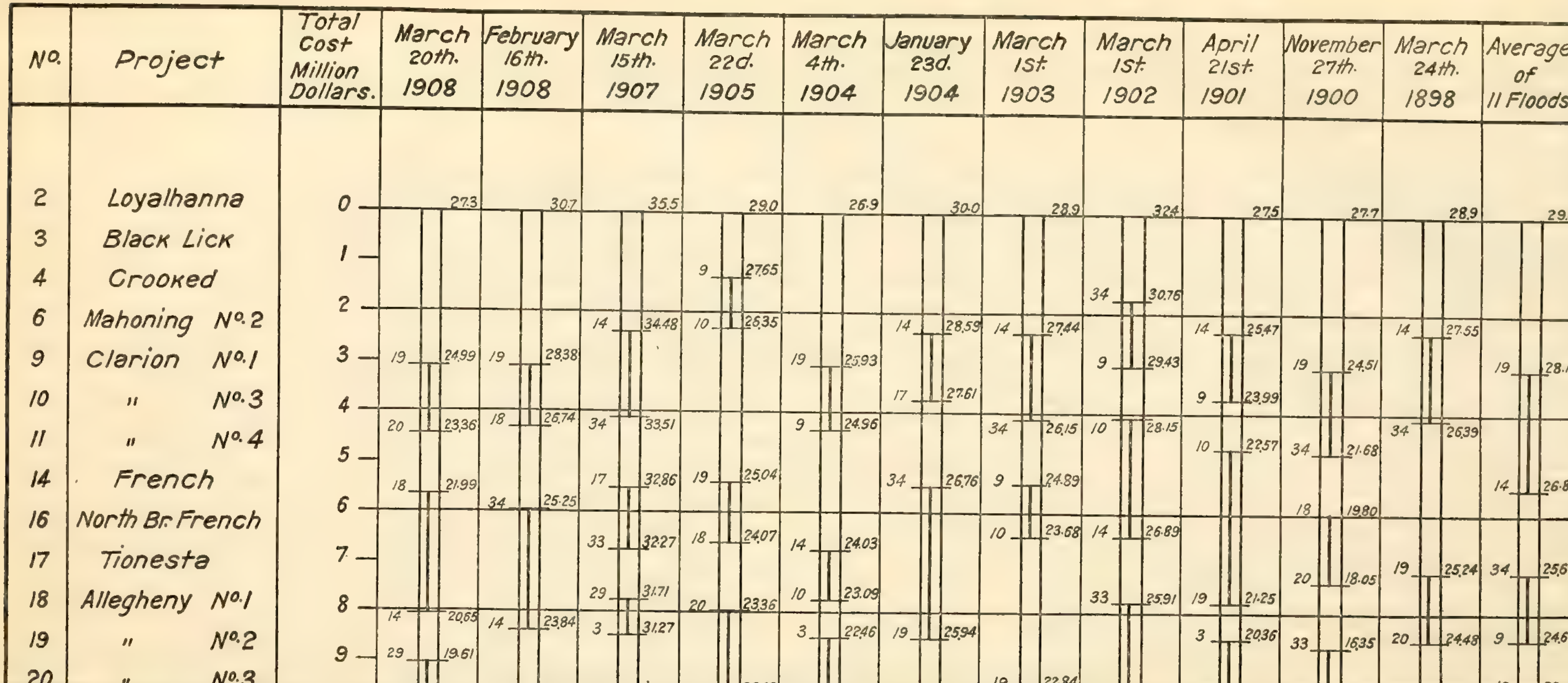

No.
Project
Gage at Pittsburgh (feet)
March 20th. 1908
February 16th. 1908
March 15th. 1907
March 22d. 1905
March 4th. 1904
January 23d. 1904
March 1st. 1903
March 1st. 1902
April 21st. 1901
November 27th. 1900
March 24th. 1898
Average of 11 Floods
*1 Buffalo
2 Loyalhanna
3 Black Lick
4 Crooked
5 Mahoning No. 1
6 " No. 2
7 Little Sandy
8 North Br. Red Bank
9 Clarion No. 1
10 " No. 3
11 " No. 4
*12 East Sandy No. 1
*13 " " No. 2
14 French
15 Cussewago
16 North Br. French
17 Tionesta
18 Allegheny No. 1
19 " No. 2
20 " No. 3
21 Kinzua
22 Laurel Hill
*23 Casselman No. 1
*24 " No. 2
*25 " No. 3
*26 " No. 4
*27 " No. 5
28 Youghiogheny No. 1
29 " No. 2
*30 " No. 3
31 " No. 4
32 " No. 5
33 Cheat No. 1
34 " No. 2
*35 Shavers Fork No. 1
*36 " " No. 2
*37 Sandy
*38 Teters
39 Buckhannon
*40 Middle Fork No. 1
*41 " " No. 2
42 Elk
43 West Fork
"Danger Line"
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
RELATIVE VALUE OF TWENTY-EIGHT RESERVOIR PROJECTS
IN REDUCING FLOOD GAGE HEIGHTS AT PITTSBURGH, PA
Dec 1910

PLATE 69



No.	Project																				
	Allegheny Watershed Totals and Averages.	8,023	91	1,105	42,178.5	$16,851,800	$ 400	69.2	77.8	12.17	12.10	5.39	7.95	7.69	7.87	7.75	7.92	11.80	12.73	8.47	9.32
29	Youghiogheny No. 2	394	76	1270	1547.1	999,300	646	5.4	4.6	1.04	0.76	0.56	0.24	0.26	0.51	0.60	0.42	0.71	1.01	0.51	0.59
33	Cheat No. 1	1399	113	1040	5737.4	1,287,900	224	19.1	5.9	0.20	0.88	0.58	0.41	0.24	0.54	0.77	0.99	0.41	1.71	0.71	0.68
34	" No. 2	—	136	1130	7294.1	1,721,900	236	—	8.0	0.33	1.50	0.97	0.68	0.40	0.85	1.29	1.64	0.68	2.84	1.17	1.12
43	West Fork	366	66	750	2724.3	811,200	298	5.0	3.7	0.15	0.57	0.41	0.29	0.08	0.43	0.47	0.51	0.34	0.45	0.08	0.35
	Monongahela Watershed Totals and Averages.	2,159	98	1,047	17,302.9	$4,820,300	$ 279	29.5	22.2	1.72	3.71	2.52	1.62	0.98	2.33	3.13	3.56	2.14	6.01	2.47	2.74
	GRAND TOTALS AND AVERAGES	10,182	93	1,091	59,481.4	$21,672,100	364	53.8	100.0	13.89	15.81	7.91	9.57	8.67	10.20	10.88	11.48	13.94	18.74	10.94	12.06

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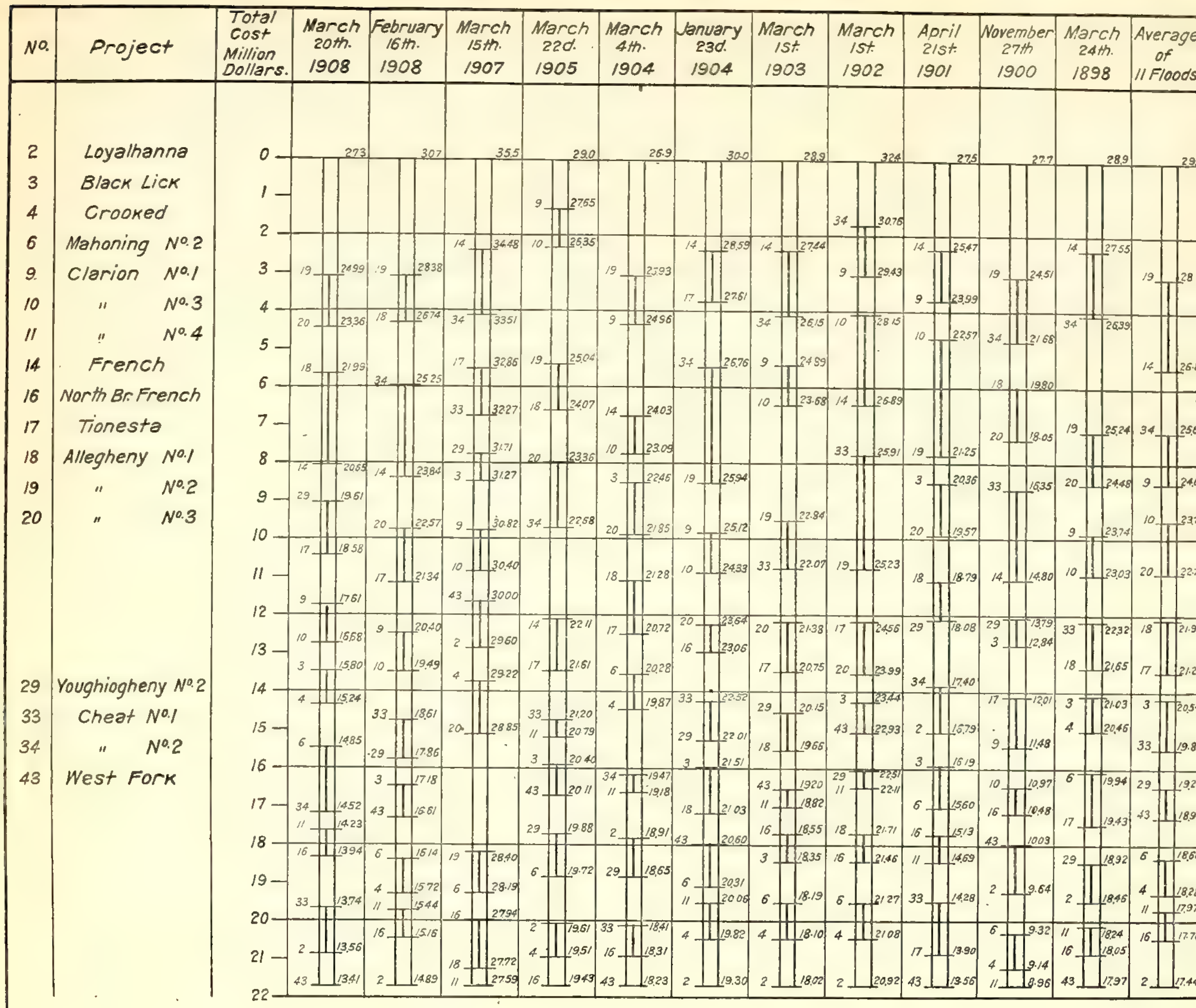


FLOOD COMMISSION,
PITTSBURGH, PA.

DIAGRAM SHOWING

RELATIVE COST OF SEVENTEEN RESERVOIR PROJECTS
IN REDUCING FLOOD GAGE HEIGHTS AT PITTSBURGH, PA.

Dec. 1910.

Note: Numbers at left of column indicate project.
" "right" " " reduced gage height.
Projects plotted from top to bottom in the order of their greatest effectiveness.

TABULATION OF ANALYSIS

No.	Project	Area Watershed Controlled (sq. miles)	Height Dam (feet)	Length Crest (feet)	Capacity Mil. Cu. Ft.	Total Cost	Cost Mil. Cu. Ft.	Watershed Controlled (per cent)	Proportion Grand Total Cost (per cent)	Relative Reduction in Gage Height at Pittsburgh, Pa. Mar 20 1908 (ft)	Feb 16 1908 (ft)	Mar 15 1907 (ft)	Mar 22 1905 (ft)	Mar 4 1904 (ft)	Jan 23 1904 (ft)	Mar 1 1903 (ft)	Mar 1 1902 (ft)	Apr 21 1901 (ft)	Nov 27 1900 (ft)	Mar 24 1898 (ft)	Average (ft)
2	Loyalhanna	277	122	1370	4112.5	$1,222,000	$ 297	2.4	5.6	0 18	0 25	0.40	0.11	0.27	0.01	0.07	0.16	0.61	0 40	0.46	0 26
3	Black Lick	414	63	1330	1454.7	720,500	495	3.6	3 3	0.88	0 68	0 45	0.39	0.63	0 50	0 22	0.55	0.89	0.95	0 62	0 69
4	Crooked	287	94	1100	32557	893,700	274	2.4	4.1	0 57	0.42	0 37	0.10	0.41	0.24	0.09	0 19	0.60	0 18	0 57	0 32
6	Mahoning No. 2	335	143	740	2367.8	1,089,400	460	2 9	5.0	0 39	0.47	0.30	0 15	0.44	0 29	0.14	0.20	0.59	0.32	0 53	0.33
9	Clarion No. 1	1212	142	880	5067.1	1,309,900	258	10.5	6 1	0.96	0 94	0 44	1.35	0 97	0.82	1.26	1.33	1 48	0 53	0 74	1 00
10	" No. 3	—	128	800	4886.6	1,028,100	210	—	4 8	0 93	0 91	0 42	1 31	0.93	0.80	1.21	1.28	1 43	0 51	0.71	0 97
11	" No. 4	—	70	880	1537.9	451,800	294	—	2.1	0 29	0 28	0.13	0.41	0 29	0 25	0.38	0 40	0.44	0 16	0.22	0.30
14	French	1009	75	1550	3323.1	2,388,100	719	8.6	11.0	1 35	1 41	1.02	0.57	0 94	1 41	1 46	1 25	2 03	1.55	1 34	1.34
16	North Br. French	217	67	1015	2125.7	722,800	340	1.9	3.3	0.29	0 28	0.25	0 08	0 10	0 58	0 27	0 25	0 46	0 49	0.19	0.27
17	Tionesta	477	103	800	3629.6	1,362,600	375	4 1	6 3	1 03	1 23	0 65	0.50	0.56	0.98	0 63	0 66	0 38	0 83	0 51	0 71
18	Allegheny No. 1	3795	63	810	2376.3	1,219,900	424	32.8	5 7	1 36	1 63	0.22	0 97	0.57	0 49	0 49	0.40	0.78	1 88	0.67	0 81
19	" No. 2	—	66	1670	4377.9	3,057,000	627	—	14 1	2.31	2 33	0 37	1.30	0.97	0 82	0.84	0 68	1 32	3.19	1.15	1 37
20	" No. 3	—	54	1415	2663.6	1,386,000	520	—	6 4	1 63	1 27	0 37	0.71	0 61	0 68	0 69	0.57	0 79	1.74	0 76	0 95
	Allegheny Watershed Totals and Averages.	8,023	91	1,105	42,178.5	$16,851,800	$ 400	69 2	77.8	12 17	12.10	5.39	7.95	7.69	7.87	7.75	7.92	11.80	12.73	8 47	9.32
29	Youghiogheny No. 2	394	75	1270	1547.1	999,300	646	5.4	4 6	1 04	0 76	0 56	0 24	0 26	0 51	0 60	0 42	0.71	1.01	0 51	0 59
33	Cheat No. 1	1399	113	1040	5737.4	1,287,900	224	19.1	5 9	0.20	0 38	0 58	0 41	0.24	0.54	0 77	0 99	0 41	1 71	0 71	0 68
34	" No. 2	—	136	1130	7294.1	1,721,900	236	—	8 0	0 33	1 50	0 97	0 68	0 40	0 85	1 29	1.64	0 68	2 84	1 17	1 12
43	West Fork	356	66	750	2724.3	811,200	298	5 0	3 7	0.15	0 57	0 41	0 29	0 08	0 43	0 47	0 51	0 34	0.45	0 08	0 35
	Monongahela Watershed Totals and Averages.	2,159	98	1,047	17,302.9	$4,820,300	$ 279	29 5	22 2	1 72	3.71	2 52	1.62	0.98	2.33	3.13	3.56	2 14	6.01	2.47	2 74
	GRAND TOTALS AND AVERAGES	10,182	93	1,091	59,481.4	$21,672,100	364	53 8	100.0	13.89	15 31	7.91	9 57	8 67	10.20	10.88	11.48	13.94	18.74	10.94	12 06

Pittsburgh," is given for each flood studied, and for the average of the eleven floods, the reduction in feet by each of the 17 projects. The sub-totals give the respective reductions in the gage heights for those projects on the Allegheny and Monongahela Basins, while the grand totals give the total reductions obtained.

From the grand totals it will be noted that the least reduction, 7.9 feet, occurred in the 1907 flood; the greatest reduction, 18.7 feet, occurred in the 1900 flood; while the average reduction in the eleven floods was 12.0 feet.

If it is desired to eliminate one or more of the 17 projects, as for example, the Loyalhanna, which is not only expensive, but also, in degree of effectiveness, lies near the foot of the list in almost every case, the probable resultant gage height in any particular flood may be obtained by adding to the bottom gage height in the above diagram the relative reduction in gage height by this project in that flood. For example, in the 1907 flood, if the Loyalhanna project were omitted at a saving of $1,222,000, the gage height at Pittsburgh would be 28.0 instead of 27.6 feet.

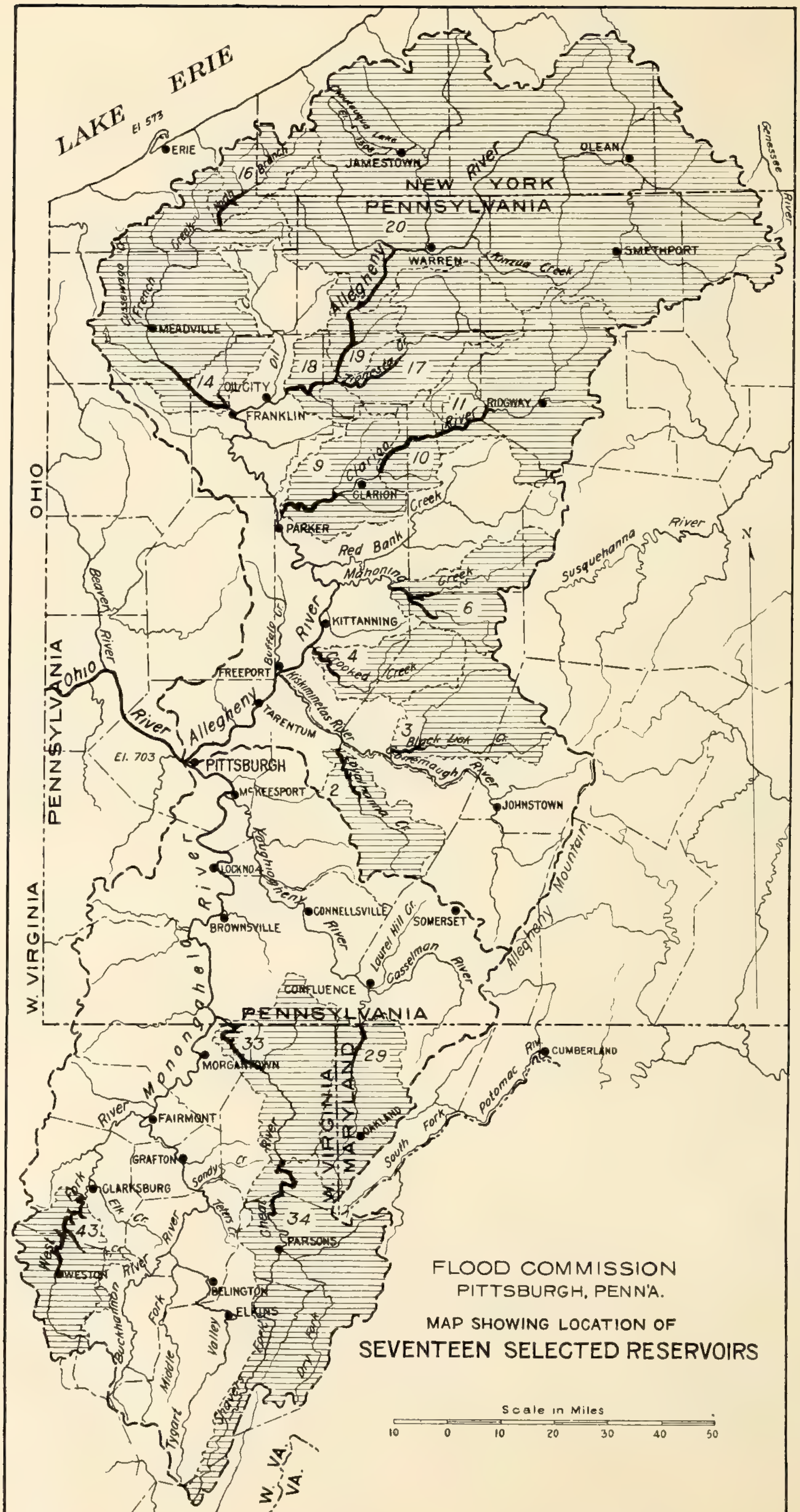
These 17 projects control 69 per cent of the Allegheny Basin, and 29.5 per cent of the Monongahela Basin, or about 54 per cent of the total drainage area above Pittsburgh. The relatively smaller drainage area placed under control on the Monongahela Basin is due to the fact that, as clearly shown on the Peak Reduction Diagrams, the flood water from the drainage areas controlled by certain of the reservoirs on that basin, for example, the Buckhannon and Middle Fork projects, always reach Pittsburgh after the main part of the flood crest at that point has subsided; and that hence the storage of these flood waters would have comparatively little lowering effect upon the Pittsburgh peak. The accompanying map, Plate 70, shows the location of the Seventeen Selected Projects and the drainage area controlled by each.

SUMMARY OF MAIN FEATURES.

A general graphical summary of the main features of each of the reservoir projects studied is given on Plate 71. The following will serve to explain certain parts of this diagram.

The term "effective capacity" refers to the portion of the reservoir capacity used in storing the "effective volume of discharge," i. e., the volume or area on the Peak Reduction Diagrams included directly below the Pittsburgh flood peak, considering only that part above the "danger line." The effective capacities as plotted on Plate 71 represent, therefore, the portions of the respective flood volume curves falling within the effective zone, or period when their ordinates can be used in reducing the portion of the Pittsburgh peak above the 22-foot stage. Where there are several reservoir projects on a stream this effective volume is divided among them in proportion to their actual capacities.

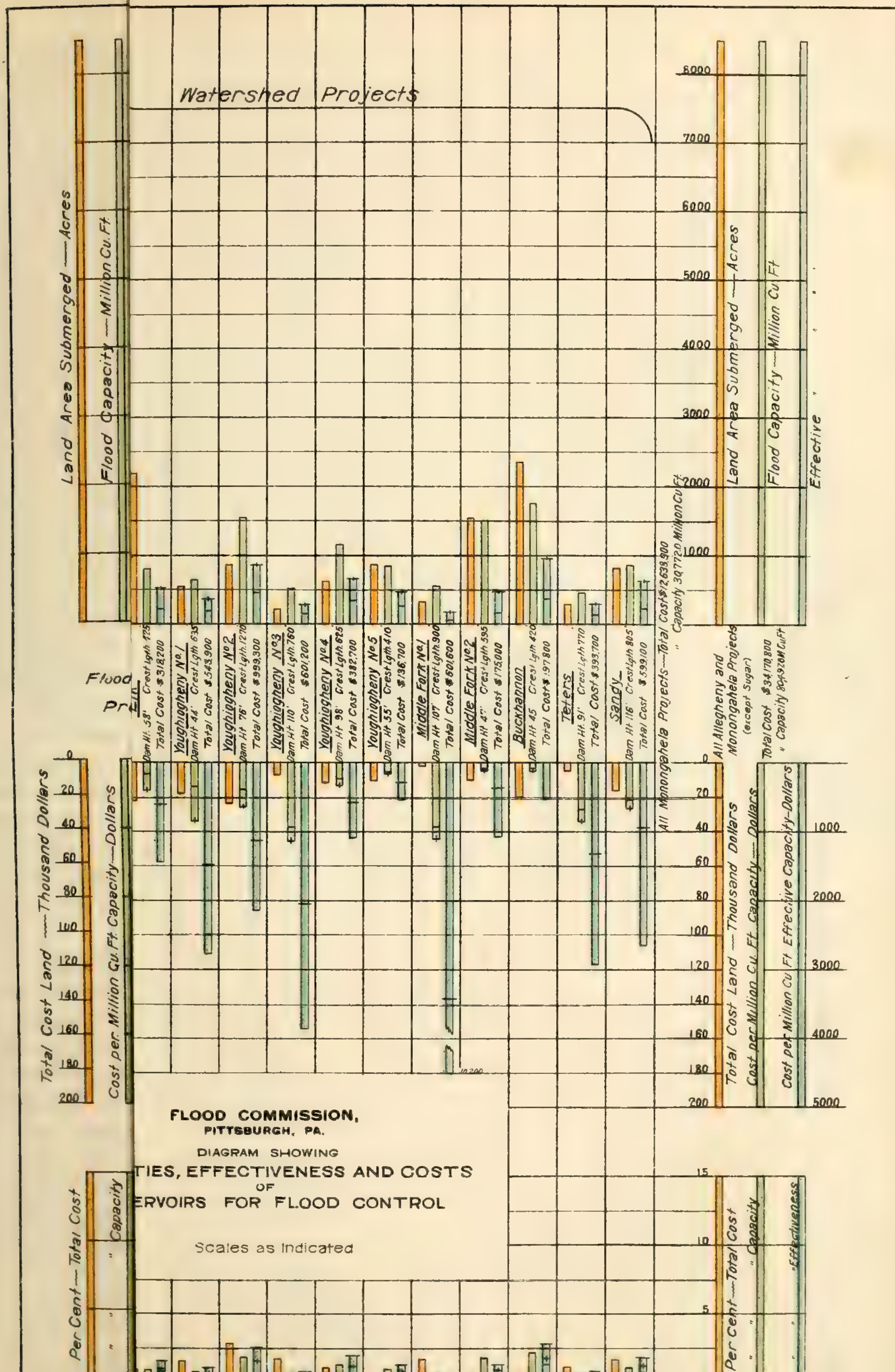
In certain cases it will be observed that the capacities of some of the reservoirs were not great enough to store this effective volume. The effective capacities of these reservoirs in such cases should be limited to their actual capacities, or to the part of those capacities remaining empty and available for the storage of the portion of the respective flood volume curves falling within the effective zone; and this has been done in the final analysis, as will be noted in the Peak Reduction Diagrams for the Seventeen Selected Projects, and in the discussion thereof. On this account, strictly speaking, the column showing effective capacity should in no case be higher than that showing flood capacity; and even where the effective volume of discharge is greater than or as great as the actual capacity, should be less in some cases, for part of the flood capacity may be used up in storing the water represented by the portion of the flood volume

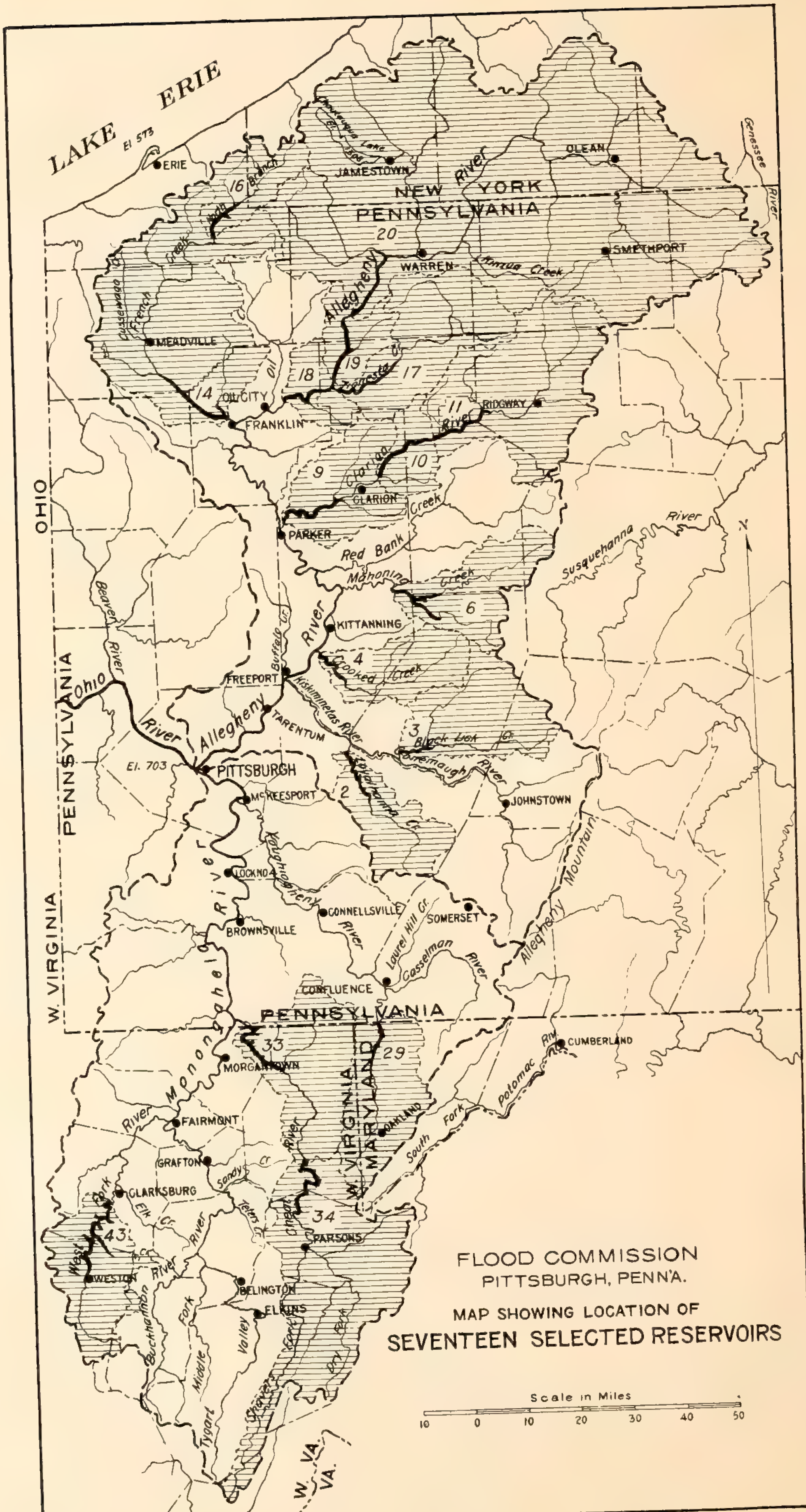


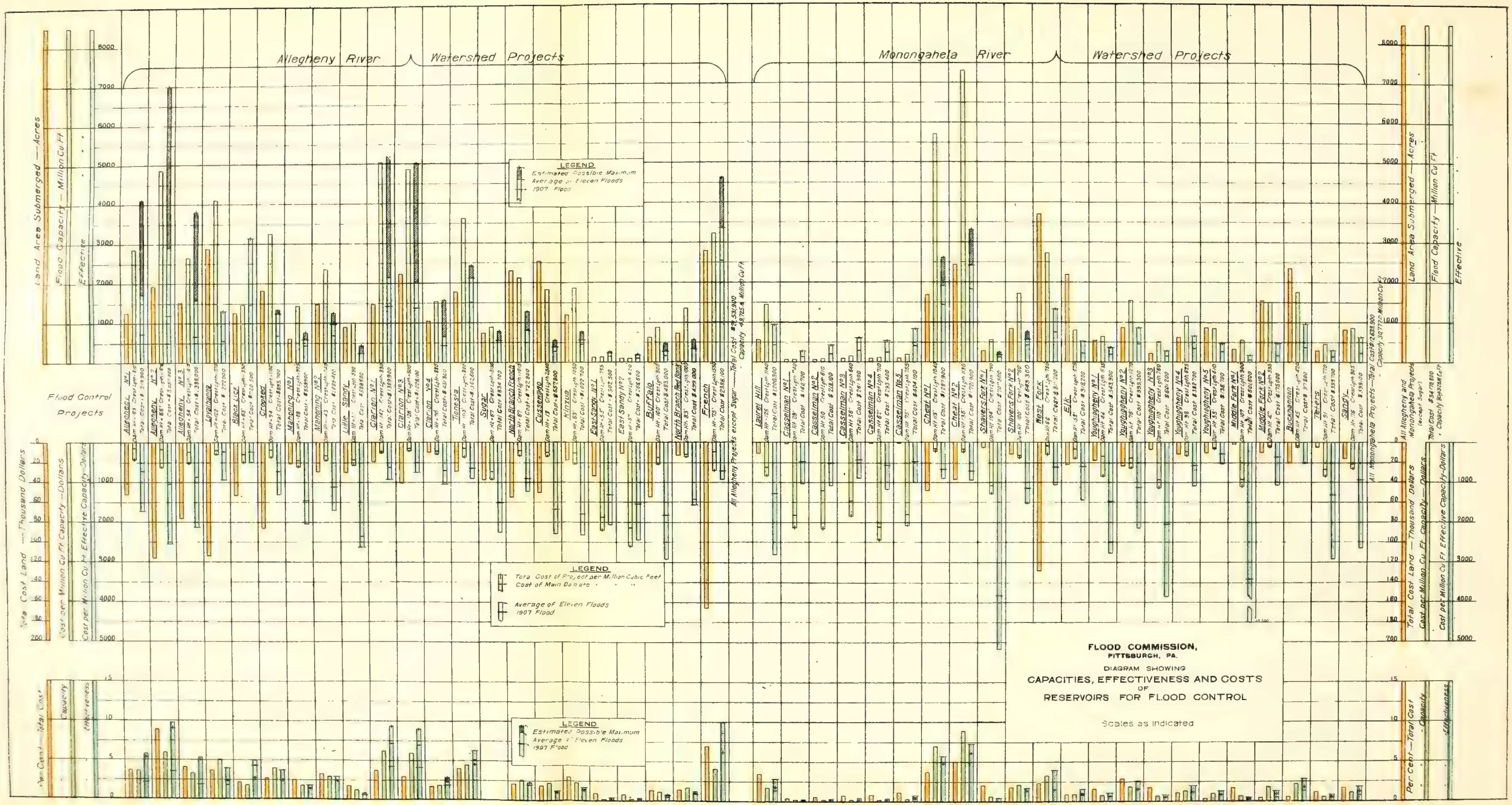
FLOOD COMMISSION
PITTSBURGH, PENN'A.

MAP SHOWING LOCATION OF
SEVENTEEN SELECTED RESERVOIRS

PLATE 71


Watershed Projects
Land Area Submerged — Acres
Flood Capacity — Million Cu. Ft.
Effective
Total Cost Land — Thousand Dollars
Cost per Million Cu. Ft. Capacity — Dollars
Cost per Million Cu. Ft. Effective Capacity — Dollars
Per Cent — Total Cost
" Capacity
" Effectiveness
Youghiogheny No. 1
Youghiogheny No. 2
Youghiogheny No. 3
Youghiogheny No. 4
Youghiogheny No. 5
Middle Fork No. 1
Middle Fork No. 2
Buckhannon
Teters
Sandy
All Monongahela Projects — Total Cost $12,638,900
" Capacity 39,772.0 Million Cu. Ft.
All Allegheny and Monongahela Projects (except Sugar)
Total Cost $34,170,800
" Capacity 80,492.0 M Cu. Ft.
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
TIES, EFFECTIVENESS AND COSTS
OF
ERVOIRS FOR FLOOD CONTROL
Scales as Indicated


FLOOD COMMISSION
PITTSBURGH, PENN'A.
MAP SHOWING LOCATION OF
SEVENTEEN SELECTED RESERVOIRS
Scale in Miles
10 0 10 20 30 40 50
LAKE ERIE
NEW YORK
PENNSYLVANIA
OHIO
W. VIRGINIA
MARYLAND
W. VA.
VA.
ERIE
JAMESTOWN
OLEAN
WARREN
SMETHPORT
MEADVILLE
OIL CITY
FRANKLIN
RIDGWAY
CLARION
PARKER
KITTANNING
FREEPORT
TARENTUM
PITTSBURGH
McKEESPORT
JOHNSTOWN
CONNELLSVILLE
SOMERSET
BROWNSVILLE
CONFLUENCE
CUMBERLAND
MORGANTOWN
FAIRMONT
GRAFTON
CLARKSBURG
OAKLAND
PARSONS
WESTON
BELINGTON
ELKINS
Allegheny River
Ohio River
Monongahela River
Youghiogheny River
Susquehanna River
Allegheny Mountain


Allegheny River Watershed Projects
Monongahela River Watershed Projects
Land Area Submerged — Acres
Flood Capacity — Million Cu Ft
Effective
Flood Control Projects
Total Cost Land — Thousand Dollars
Cost per Million Cu Ft Capacity — Dollars
Cost per Million Cu Ft Effective Capacity — Dollars
Per Cent — Total Cost
Capacity
Effectiveness
LEGEND
Estimated Possible Maximum
Average of Eleven Floods
1907 Flood
LEGEND
Total Cost of Project per Million Cubic Feet
Cost of Main Dam etc.
Average of Eleven Floods
1907 Flood
LEGEND
Estimated Possible Maximum
Average of Eleven Floods
1907 Flood
Allegheny No 1
Allegheny No 2
Allegheny No 3
Loyalhanna
Black Lick
Crooked
Mahoning No 1
Mahoning No 2
Little Sandy
Clarion No 1
Clarion No 3
Clarion No 4
Tionesta
Sugar
North Branch French
Cussewago
Kinzua
East Sandy No 1
East Sandy No 2
Buffalo
North Branch Red Bank
French
All Allegheny Projects except Sugar
Laurel Hill
Casselman No 1
Casselman No 2
Casselman No 3
Casselman No 4
Casselman No 5
Cheat No 1
Cheat No 2
Shavers Fork No 1
Shavers Fork No 2
West Fork
Elk
Youghiogheny No 1
Youghiogheny No 2
Youghiogheny No 3
Youghiogheny No 4
Youghiogheny No 5
Middle Fork No 1
Middle Fork No 2
Buckhannon
Teters
Sandy
All Monongahela Projects
All Allegheny and Monongahela Projects (except Sugar)
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
CAPACITIES, EFFECTIVENESS AND COSTS
OF
RESERVOIRS FOR FLOOD CONTROL
Scales as indicated

curve falling outside of and before the effective zone. But in order to bring out, for each reservoir, the relation between the actual flood capacity and the volume of damaging flood water that may be delivered from the stream in question, and to show thereby which reservoirs have ample capacity for all possible floods and which are sometimes lacking in capacity, this effective volume is plotted to its full amount, just as if there were in every case reservoir capacity to store the water it represents. These columns of "effective capacity" furnish, moreover, a correct and useful index as to the relative importance of the control of the areas tributary to the various projects in the reduction of the Pittsburgh flood peaks; in other words, they show the extent of their contributions of damaging flood water.

In these graphical studies by means of the Peak Reduction Diagrams, in fact, the method of procedure has been to first ascertain the effect upon the Pittsburgh peak of removing the individual flood volumes contributed by the drainage areas above certain selected points on the various tributaries of the two rivers, these points being the dam sites of the proposed reservoirs. It was not, at this stage of the studies, a question of storage, for it had not yet been determined that storage at all the respective points selected would be effective or desirable.

The individual flood volume curves for the respective drainage areas in the various floods studied were therefore plotted under the corresponding Pittsburgh peaks, and the reduced peaks obtained as described above. An analysis was then made of the relative effect of the removal or storage of these flood volume curves in reducing the Pittsburgh peak. By this process, as already described in detail, the least effective projects were eliminated and the seventeen most effective projects were selected.

It then became a question of whether sufficient capacity was available at the sites of each of these Seventeen Selected Projects to completely store the water represented by the respective flood volume curves. It was found that in certain floods several of these reservoirs filled up before the end of the flood. Peak Reduction Diagrams for the Seventeen Selected Projects were therefore constructed, in which the reservoirs were not considered effective beyond their actual capacities; in other words, as soon as they were filled, the ordinates of the respective flood volume curves were no longer used in reducing the Pittsburgh peak. These diagrams, Plates 72 to 82, are shown later in this chapter.

It is possible, however, by proper manipulation of the reservoir gates, to make a reservoir control more flood water than it actually stores. In a reservoir of less capacity than the flood volume from its catchment area, the object is, of course, to store only the part of the flood water represented by the portion of the flood volume curve falling within the effective zone under the Pittsburgh peak, and this could be effected by suitable regulation of the discharging apparatus at the dam. In the construction of the Peak Reduction Diagrams for the Seventeen Selected Projects, as has already been stated, the reservoirs were not considered effective beyond their capacity to dam crest, and the resultant peak reductions were therefore less in some cases than would be expected in actual operation, when there would be proper regulation of reservoir gates. In the construction of the Peak Reduction Diagrams for the 43 projects, however, it was considered that in cases where complete flood storage was not possible, there would be proper regulation of the reservoir gates to prevent any part of the controlled flood water reaching Pittsburgh at the time of the flood crest.

This condition of greater effective flood volume than actual reservoir capacity is shown on Plate 71 in the case of the Allegheny, Black Lick, French and Cassel-

man projects. It is true also of the Clarion project, but to so slight an amount as to be negligible. In the case of the Allegheny and French projects, this excess occurs only with "estimated possible maximum," while in the case of the Black Lick and Casselman projects it takes place in the 1907 flood as well. The areas controlled by these projects deliver a large amount of their flood waters at Pittsburgh before peak time, and in actual operation this water would be passed on through the gates and the storage capacity reserved for impounding the water represented by the latter and damaging part of their flood volume curves.

Certain other reservoir projects, for example, Loyalhanna, Crooked, Cussewago, Kinzua, Cheat No. 1, Cheat No. 2, West Fork and others, indicate that the reservoirs have a considerably greater capacity than is necessary to care for the floods studied, and a saving in cost could be made by cutting down the reservoirs to a capacity more nearly equal to the effective capacity required. Each reservoir, however, should have a certain factor of safety, or excess capacity, to provide not only for inaccuracies in results, due to incomplete original data used in the study of the eleven floods considered, but also for possible greater future floods.

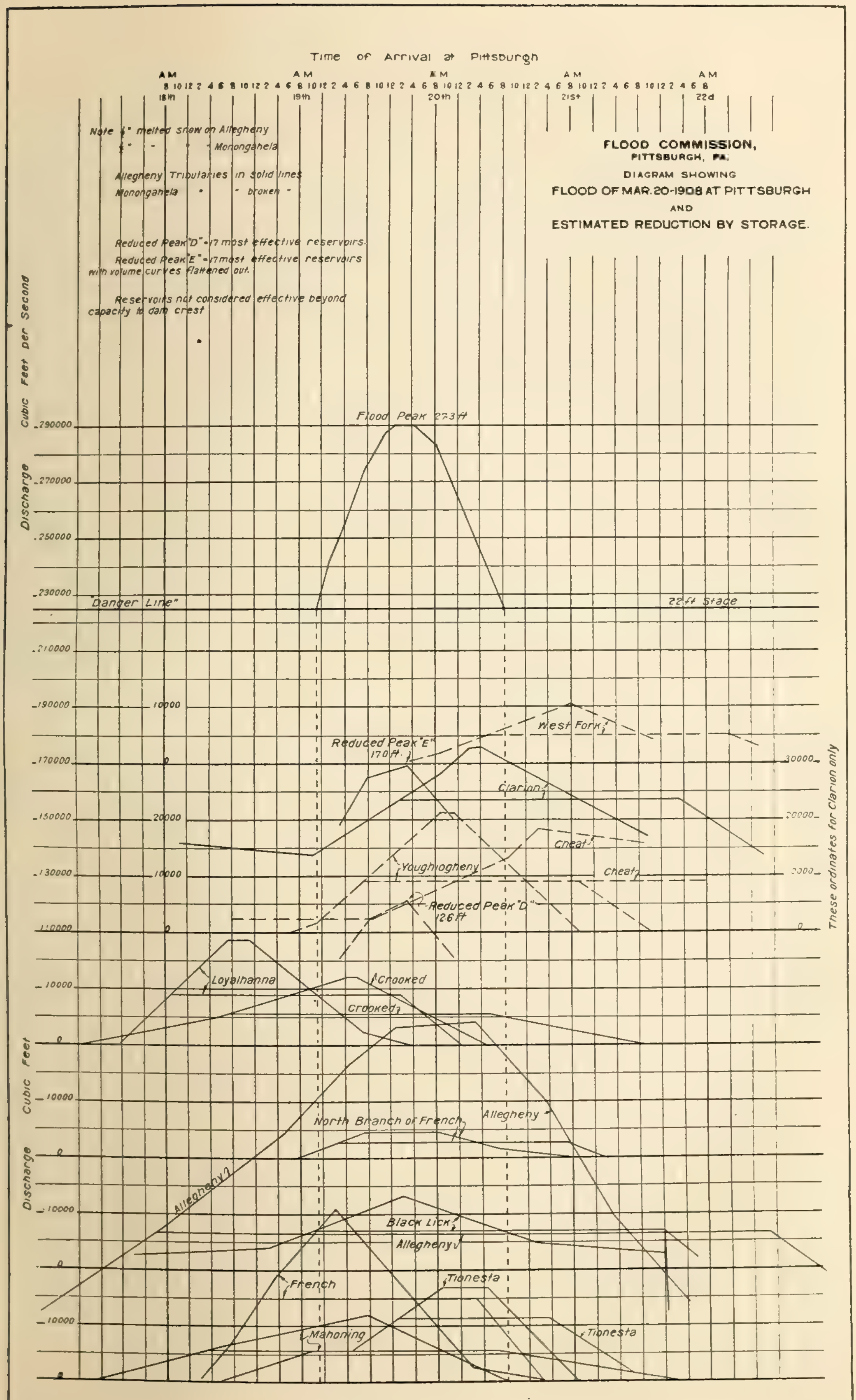
In the computation of the "per cent of total effectiveness" in the lowest scale of the diagram, only the actual capacities of the reservoirs have been considered as being effective. This lowest scale is a rapid guide in determining which projects are most desirable. For example, when the second column for any project is higher than the first, it is evident that the cost of storage is below the average, and vice versa. Again, when the third column is higher than the second, the project has greater effectiveness than the average. If the third column is higher than the first, moreover, it shows that this effectiveness is obtained at a lower cost than the average.

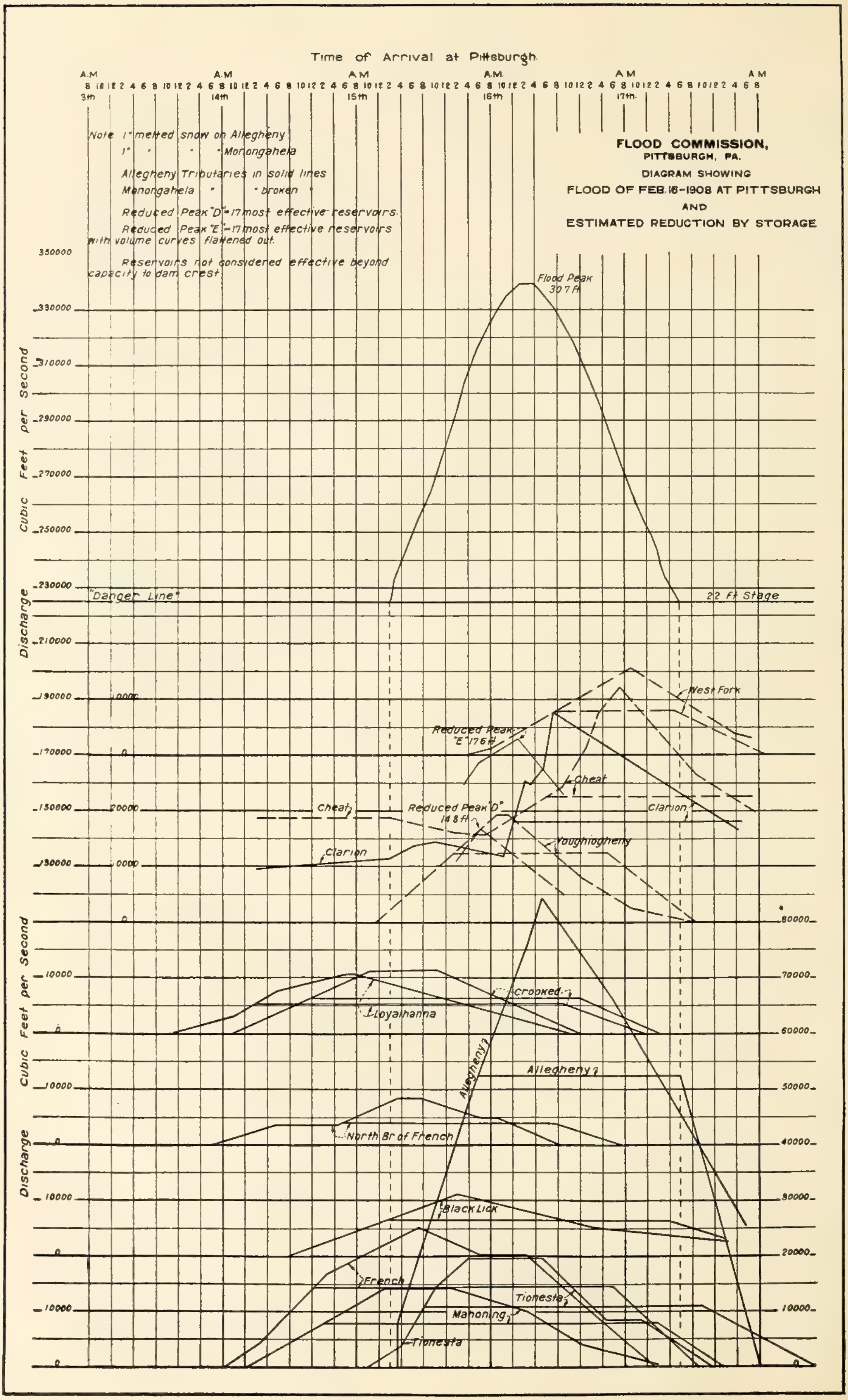
PEAK REDUCTION DIAGRAMS. SEVENTEEN SELECTED PROJECTS.

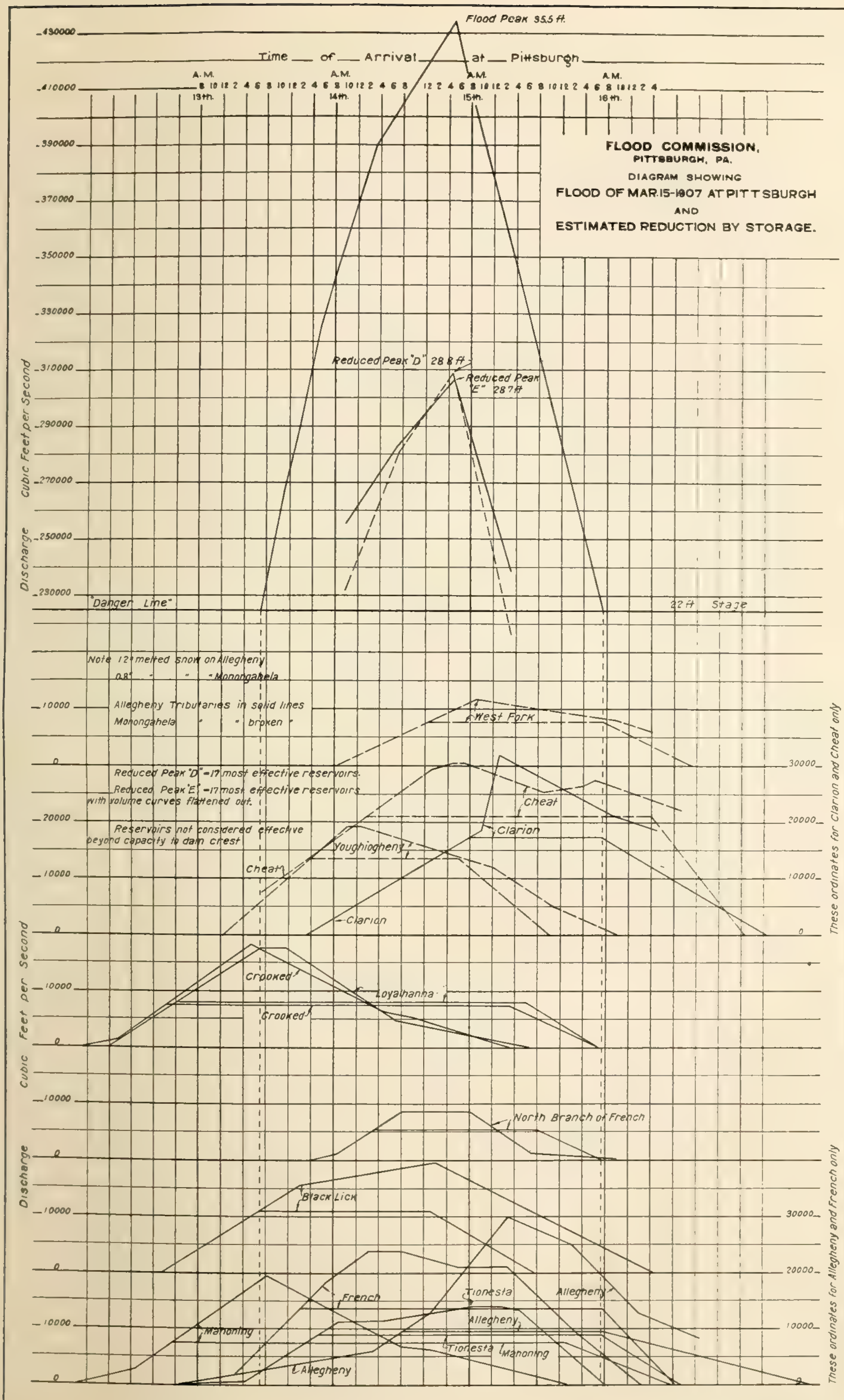
In the construction of these diagrams, as previously stated, the reservoirs have not been considered effective beyond their actual capacities. This is conservative, as in actual practice there would naturally be a considerable increase of effective capacity by proper manipulation of the gates at the dams. These 17 projects really include eight others, as the Allegheny projects control the area covered by the Kinzua project; the French project not only does away with the Sugar project, but also controls the water from the Cussewago; the Youghiogheny reservoir No. 2 controls the area covered by reservoirs 3, 4 and 5 on that stream; and the Cheat projects control the area covered by Shavers Fork reservoirs Nos. 1 and 2.

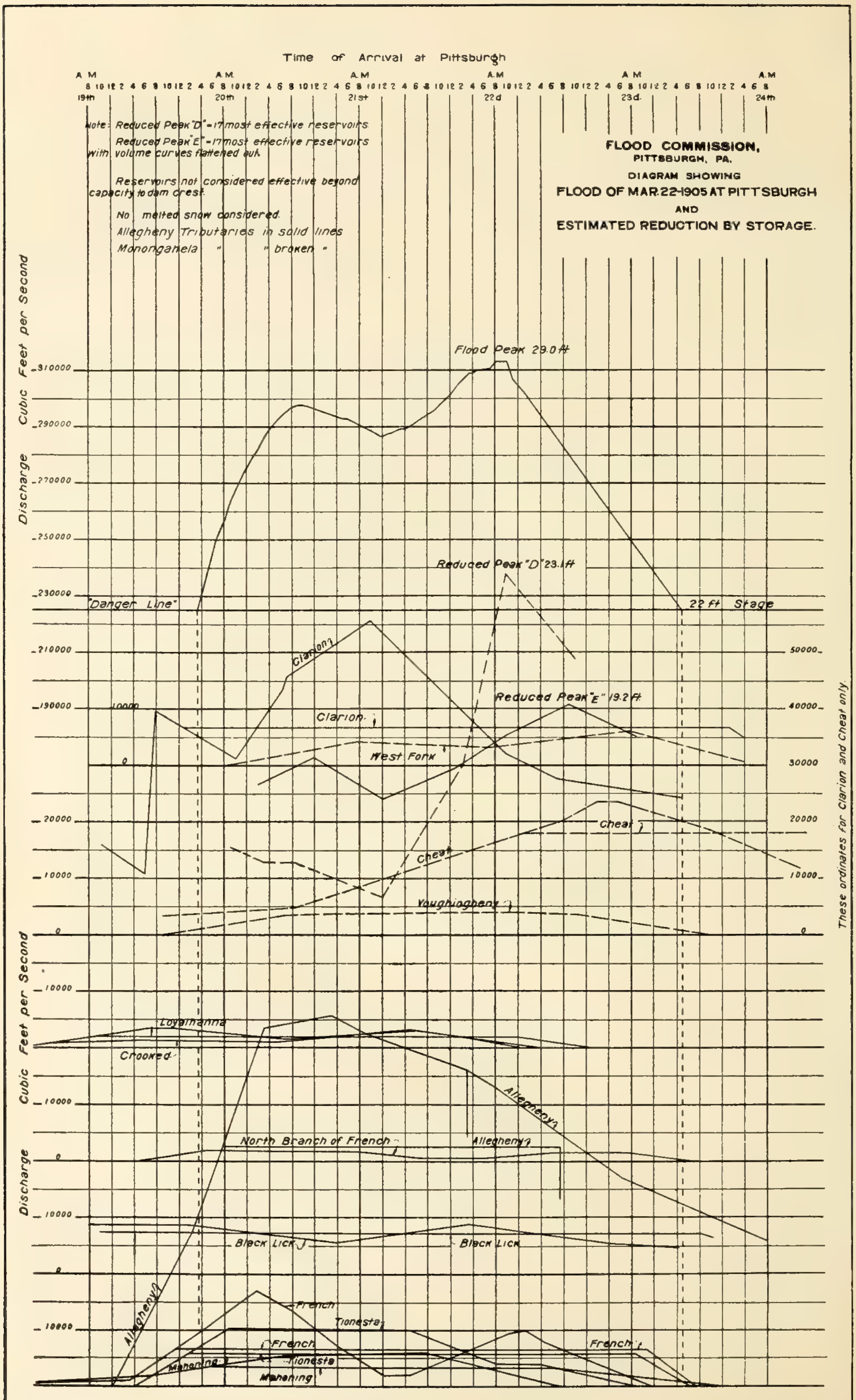
The time of arrival of the extreme flood stage of the reduced peak in these diagrams is often, as naturally to be expected, somewhat different from that obtained by using the entire 43 reservoir projects. The peak reductions obtained with this small number of projects, when compared with the corresponding reductions effected by the entire number, indicate clearly the relatively small decrease in flood stage produced by the projects other than the 17 selected.

It is evident that the form of the flood volume curves for the respective streams would change in the movement of their waters down to Pittsburgh, with consequent change in the form of the volume curves placed under the Pittsburgh flood peak on the diagrams. This changed form upon arrival at Pittsburgh would be somewhere between the form at the respective dam sites and the flattened-out form obtained by spreading the tributary floods over the time from beginning to end of the flood at the average rate of flow. The tributary volume curves for the 17 projects have been flattened out in this way and are shown on the diagrams, together with the resultant peak reductions.


Time of Arrival at Pittsburgh
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 20-1908 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Allegheny Tributaries in Solid lines
Monongahela " " broken "
Reduced Peak "D" = 17 most effective reservoirs.
Reduced Peak "E" = 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest
Discharge Cubic Feet per Second
Flood Peak 27.3 ft
"Danger Line"
22 ft Stage
West Fork
Reduced Peak "E" 17.0 ft
Clarion
Cheat
Youghiogheny
Reduced Peak "D" 12.6 ft
These ordinates for Clarion only
Loyalhanna
Crooked
North Branch of French
Allegheny
Black Lick
French
Tionesta
Mahoning


Time of Arrival at Pittsburgh
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF FEB.16-1908 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE
Note 1" melted snow on Allegheny
1" " " " Monongahela
Allegheny Tributaries in solid lines
Monongahela " " broken
Reduced Peak "D" = 17 most effective reservoirs.
Reduced Peak "E" = 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
Flood Peak 30.7 ft
"Danger Line"
22 ft Stage
Discharge Cubic Feet per Second
West Fork
Reduced Peak "E" 17.6 ft
Cheat
Clarion
Reduced Peak "D" 14.8 ft
Youghiogheny
Crooked
Loyalhanna
Allegheny
North Br of French
Black Lick
French
Tionesta
Mahoning


FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR.15-1907 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Flood Peak 35.5 ft.
Time of Arrival at Pittsburgh
Reduced Peak "D" 28.8 ft.
Reduced Peak "E" 28.7 ft.
"Danger Line"
22 ft Stage
Note 1.2" melted snow on Allegheny
0.8" " " " Monongahela
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "D" = 17 most effective reservoirs.
Reduced Peak "E" = 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest
West Fork
Cheat
Clarion
Youghiogheny
Crooked
Loyalhanna
North Branch of French
Black Lick
French
Tionesta
Allegheny
Mahoning
Discharge Cubic Feet per Second
These ordinates for Clarion and Cheat only
These ordinates for Allegheny and French only



Time of Arrival at Pittsburgh
A.M.
19th
20th
21st
22d
23d.
24th
Note: Reduced Peak "D" = 17 most effective reservoirs
Reduced Peak "E" = 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
No melted snow considered.
Allegheny Tributaries in solid lines
Monongahela " " broken "
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 22-1905 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Discharge Cubic Feet per Second
Flood Peak 29.0 ft
Reduced Peak "D" 23.1 ft
"Danger Line"
22 ft Stage
Reduced Peak "E" 19.2 ft
Clarion
West Fork
Cheat
Youghiogheny
These ordinates for Clarion and Cheat only.
Loyalhanna
Crooked
Allegheny
North Branch of French
Black Lick
French
Tionesta
Mahoning
310000
290000
270000
250000
230000
210000
190000
20000
10000
0
50000
40000
30000

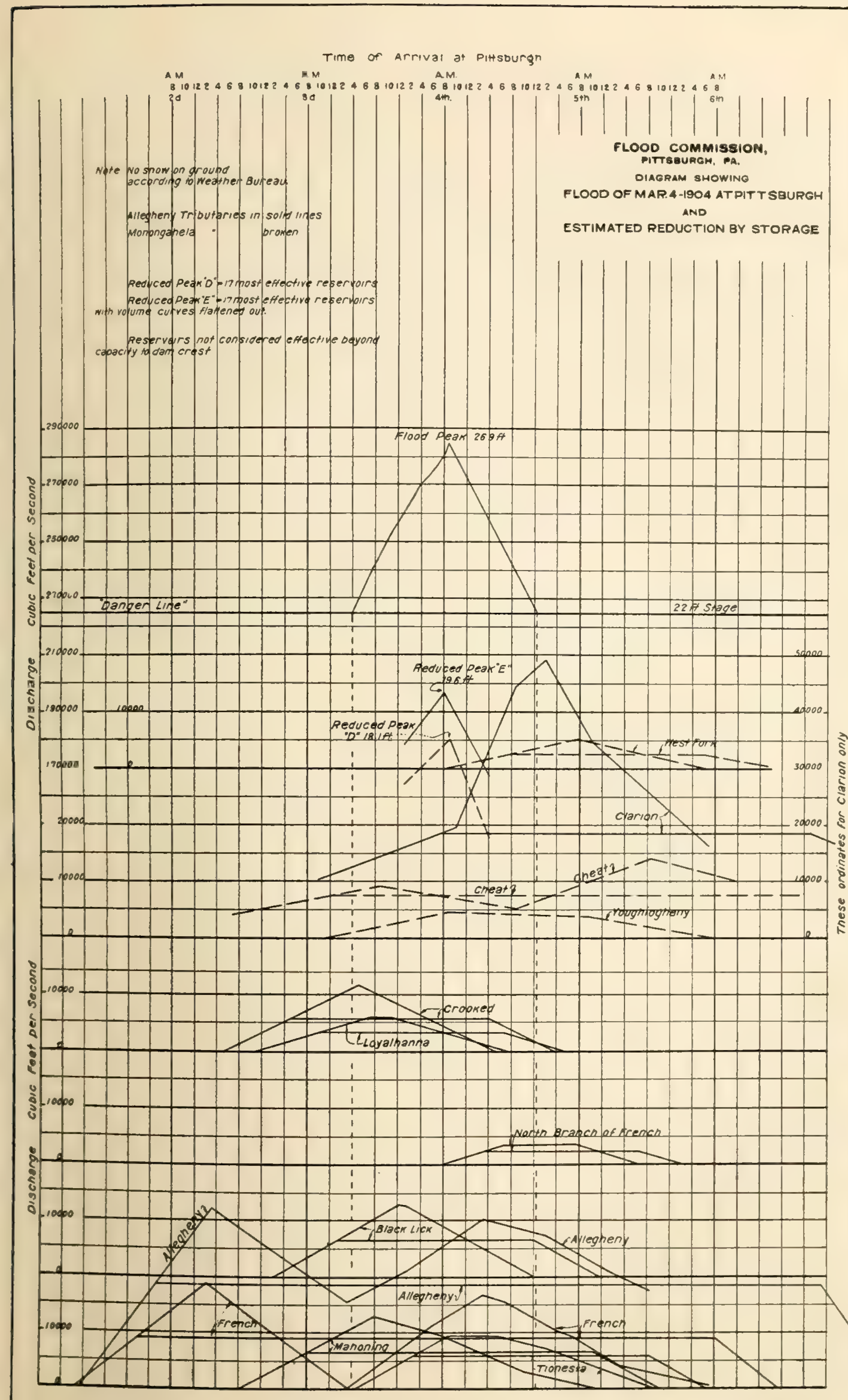
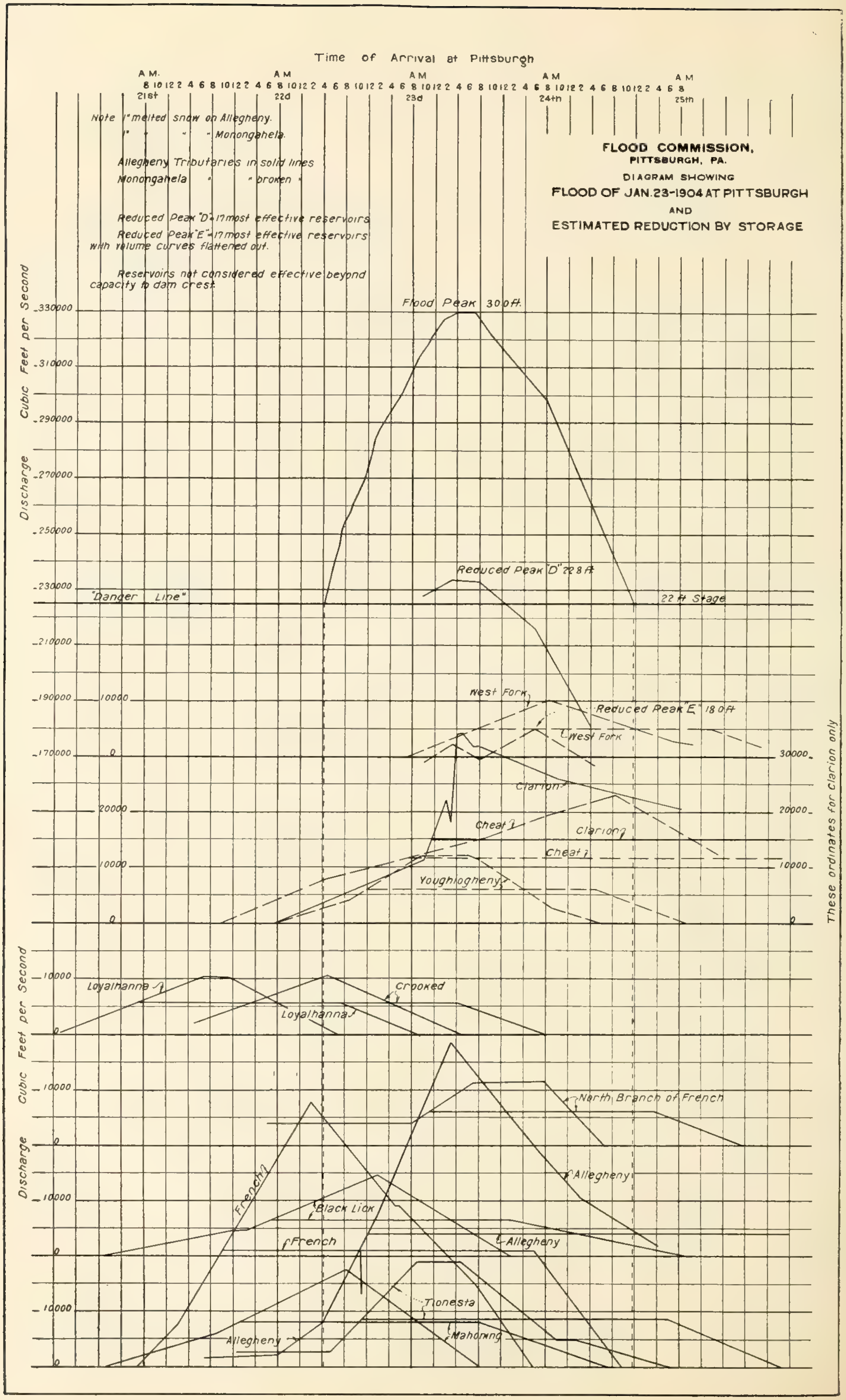

FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 4-1904 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE
Time of Arrival at Pittsburgh
Note No snow on ground according to Weather Bureau.
Allegheny Tributaries in solid lines
Monongahela " broken
Reduced Peak "D" - 17 most effective reservoirs
Reduced Peak "E" - 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest
Flood Peak 26.9 ft
"Danger Line"
22 ft Stage
Reduced Peak "E" 19.6 ft
Reduced Peak "D" 18.1 ft
West Fork
Clarion
Cheat
Youghiogheny
Crooked
Loyalhanna
North Branch of French
Allegheny
Black Lick
French
Mahoning
Tionesta
Discharge Cubic Feet per Second
These ordinates for Clarion only

PLATE 77


Time of Arrival at Pittsburgh
A.M. 8 10 12 2 4 6 8 10 12 2 4 6 21st
A M 8 10 12 2 4 6 8 10 12 2 4 6 22d
A M 8 10 12 2 4 6 8 10 12 2 4 6 23d
A M 8 10 12 2 4 6 8 10 12 2 4 6 24th
A M 8 25th
Note 1" melted snow on Allegheny.
1" " " " Monongahela.
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "D" 17 most effective reservoirs
Reduced Peak "E" 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF JAN. 23-1904 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE
Discharge Cubic Feet per Second
330000
310000
290000
270000
250000
230000
210000
190000
170000
Flood Peak 30.0 ft.
Reduced Peak "D" 22.8 ft.
"Danger Line"
22 ft Stage
West Fork
Reduced Peak "E" 18.0 ft.
West Fork
Clarion
Cheat
Clarion
Cheat
Youghiogheny
10000
0
20000
10000
0
30000
20000
10000
0
These ordinates for Clarion only
Discharge Cubic Feet per Second
10000
0
Loyalhanna
Crooked
Loyalhanna
10000
0
North Branch of French
Allegheny
French
10000
Black Lick
French
Allegheny
0
Tionesta
10000
Allegheny
Mahoning
0

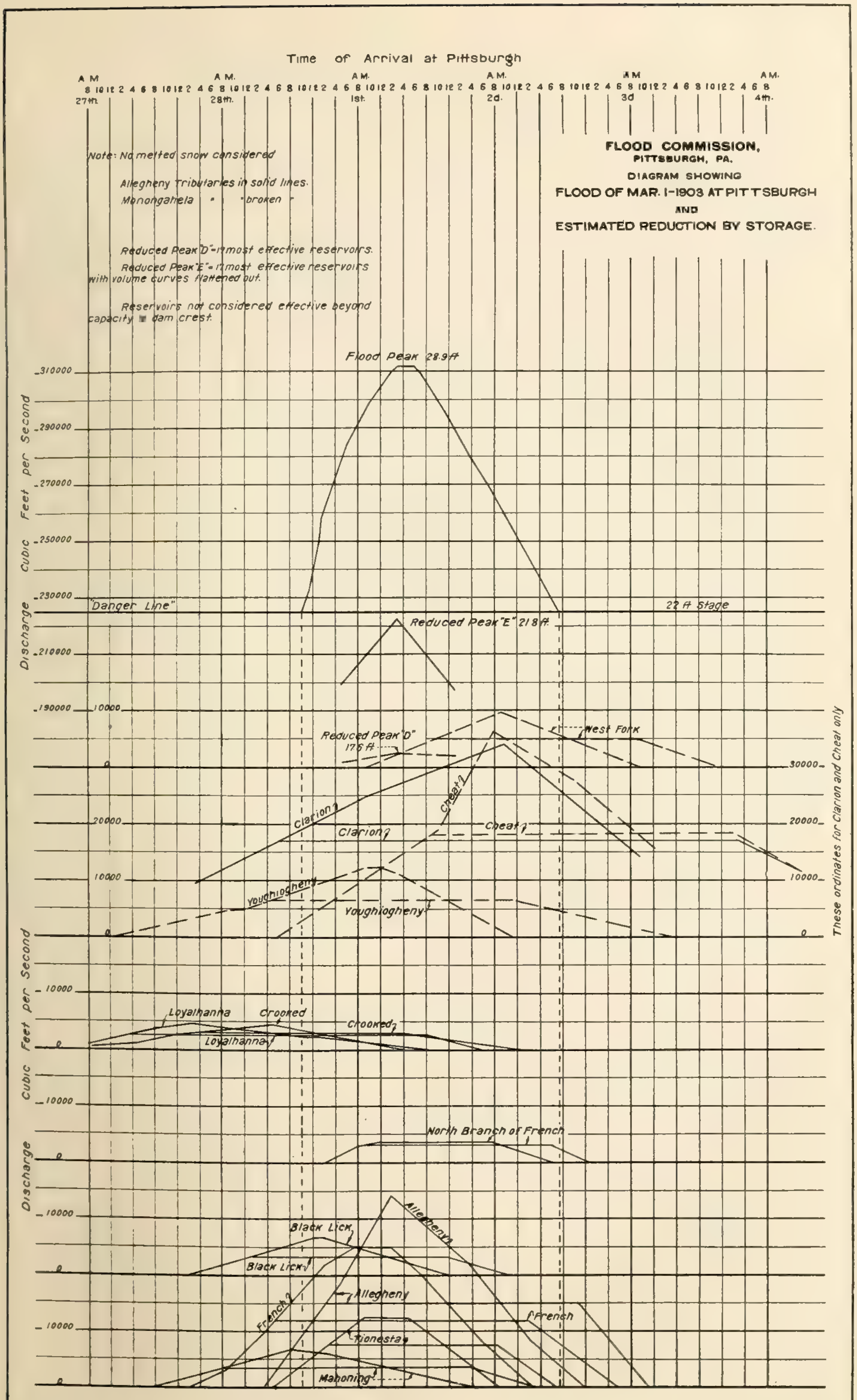
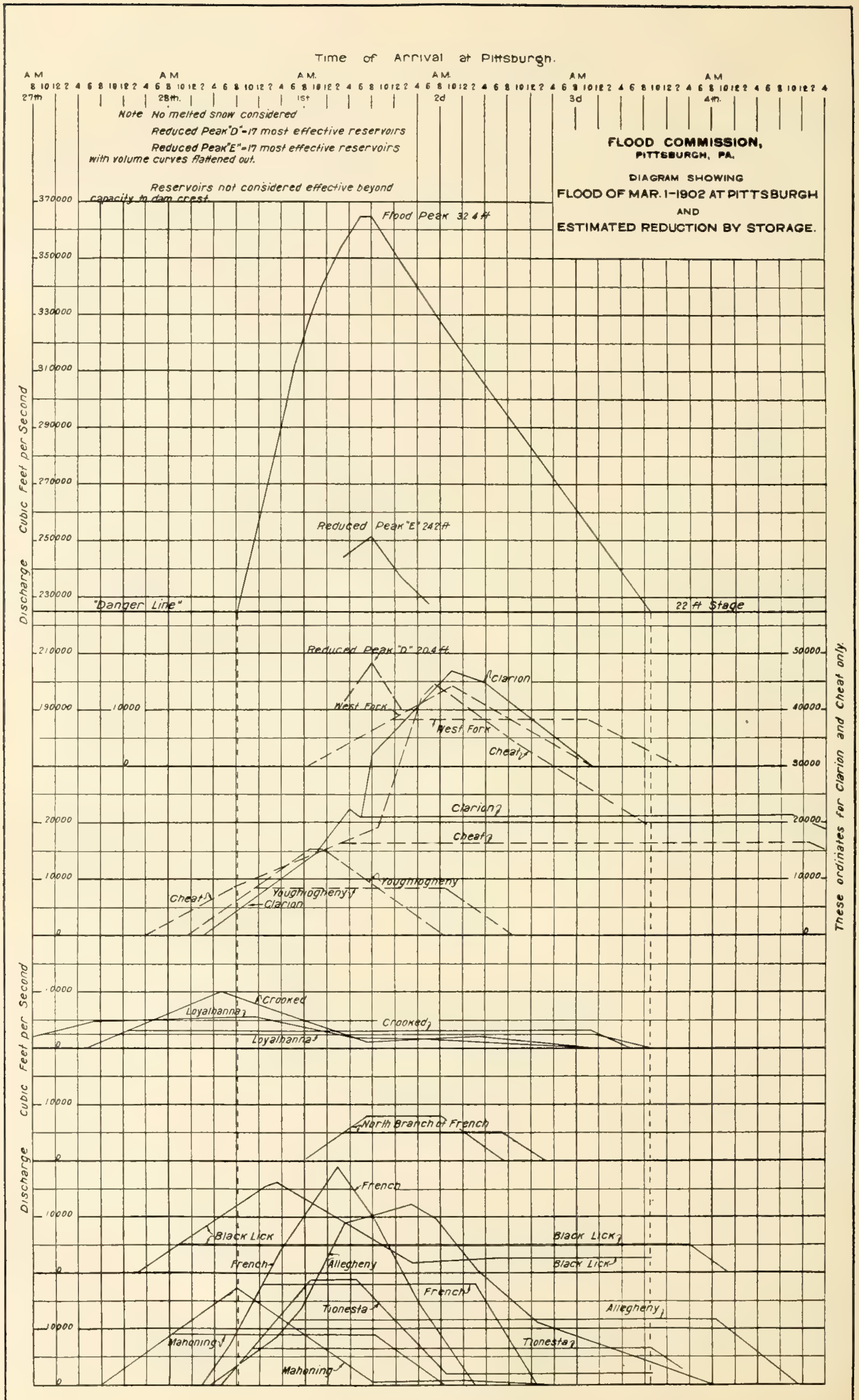
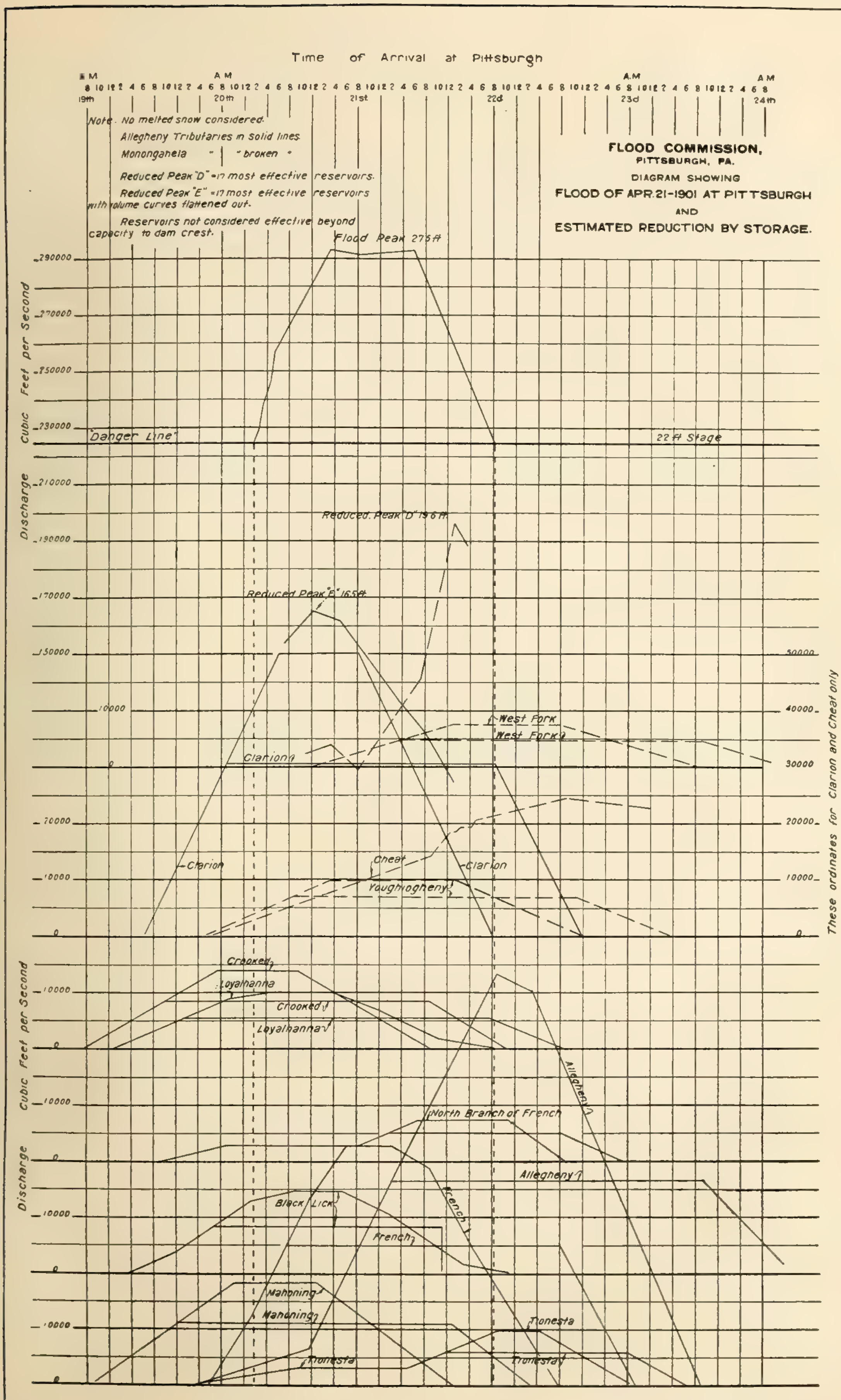

Time of Arrival at Pittsburgh
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 1-1903 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Note: No melted snow considered
Allegheny Tributaries in solid lines.
Monongahela " " broken "
Reduced Peak "D" - 17 most effective reservoirs.
Reduced Peak "E" - 17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity at dam crest.
Flood Peak 28.9 ft
"Danger Line"
22 ft Stage
Reduced Peak "E" 21.8 ft.
Reduced Peak "D" 17.5 ft
West Fork
Clarion
Cheat
Youghiogheny
Loyalhanna
Crooked
North Branch of French
Black Lick
Allegheny
French
Tionesta
Mahoning
Discharge Cubic Feet per Second
These ordinates for Clarion and Cheat only

PLATE 79

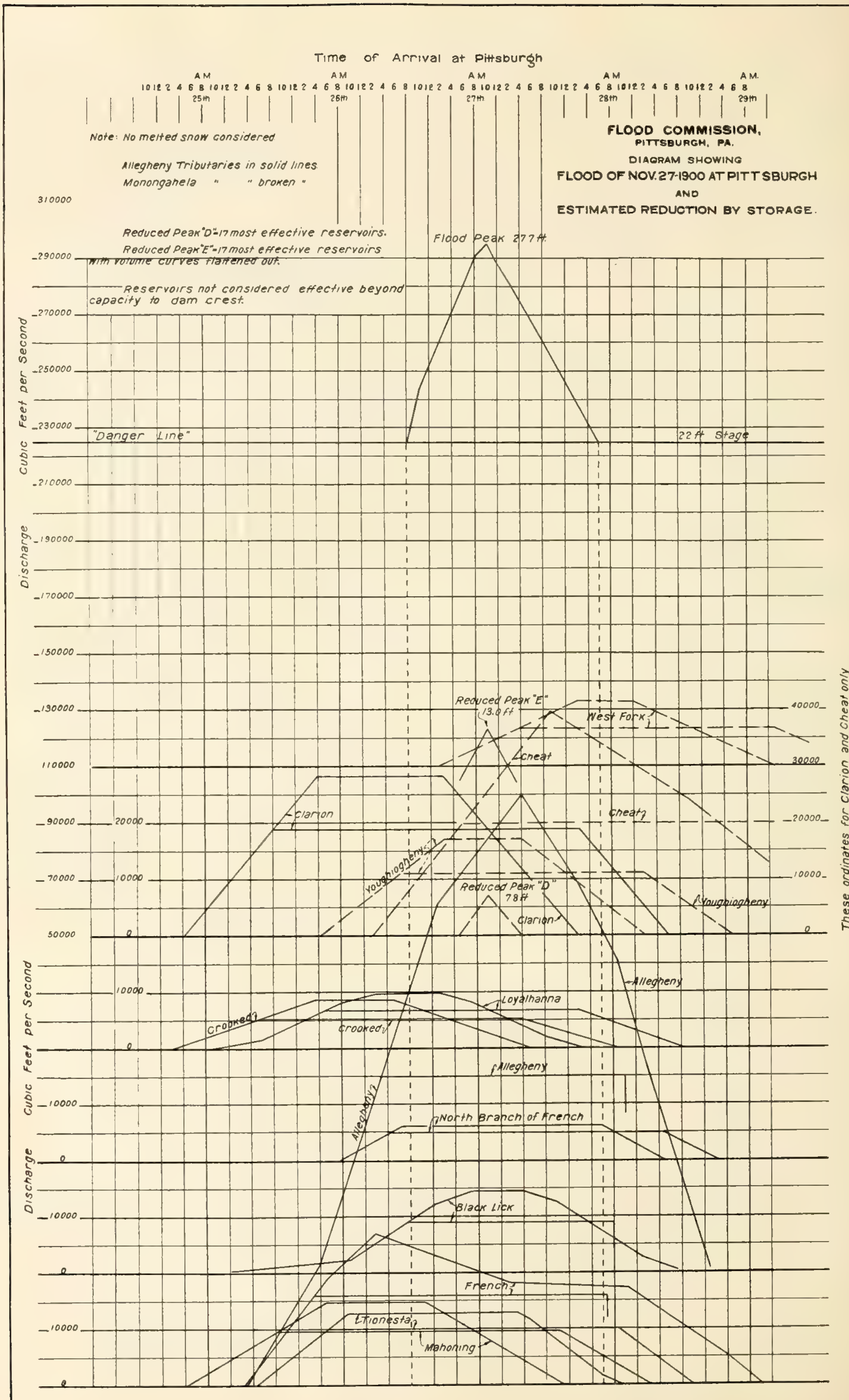


Time of Arrival at Pittsburgh.
Note No melted snow considered
Reduced Peak "D"=17 most effective reservoirs
Reduced Peak "E"=17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
FLOOD COMMISSION, PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 1-1902 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Flood Peak 32.4 ft
Reduced Peak "E" 24.2 ft
"Danger Line"
22 ft Stage
Reduced Peak "D" 20.4 ft.
Discharge Cubic Feet per Second
These ordinates for Clarion and Cheat only.
Clarion
West Fork
Cheat
Youghiogheny
Crooked
Loyalhanna
North Branch of French
French
Black Lick
Allegheny
Tionesta
Mahoning

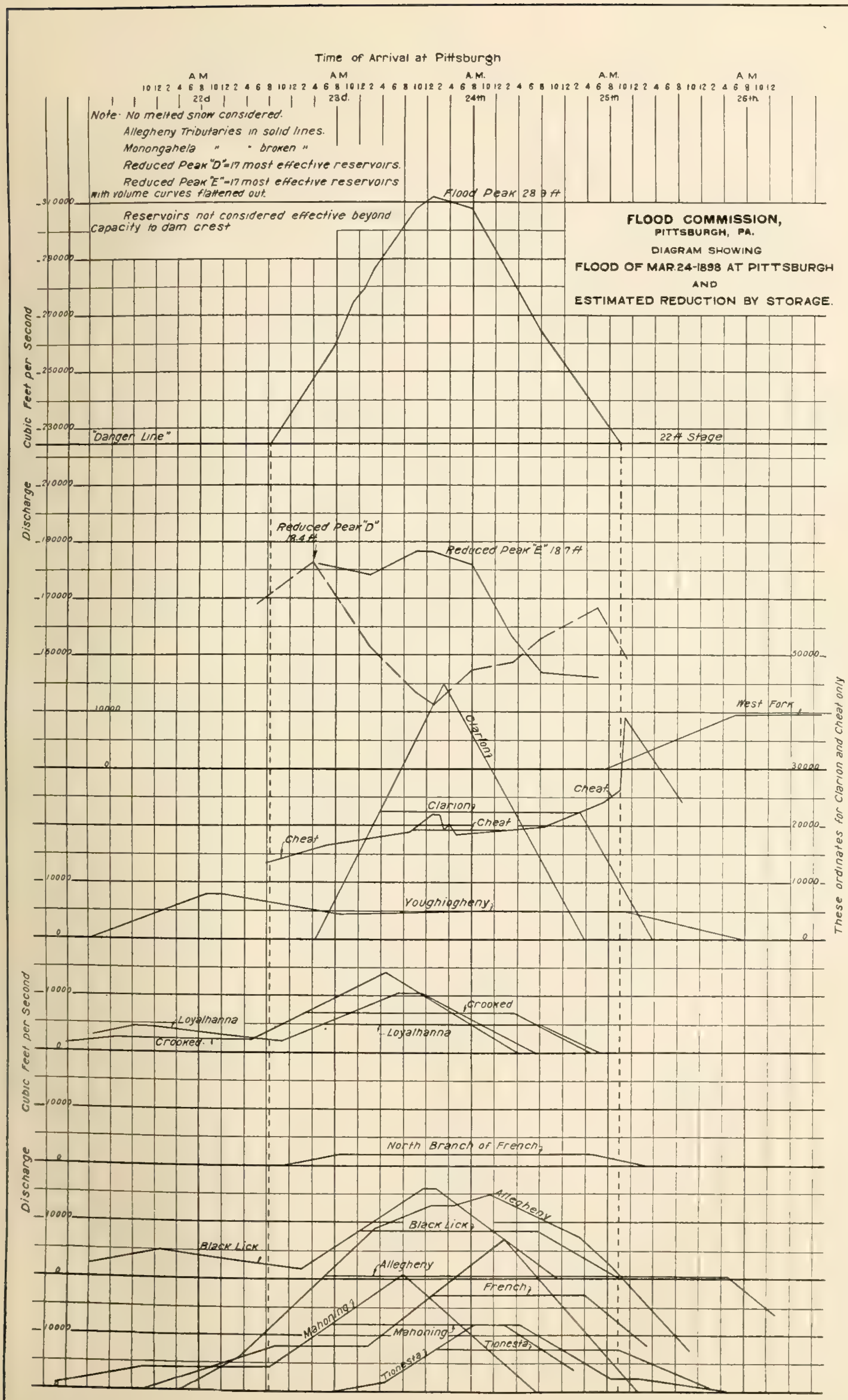
PLATE 80



Time of Arrival at Pittsburgh
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF APR.21-1901 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Note. No melted snow considered.
Allegheny Tributaries in solid lines
Monongahela " " broken "
Reduced Peak "D" =17 most effective reservoirs.
Reduced Peak "E" =17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
Flood Peak 27.5 ft
Danger Line
22 ft Stage
Reduced Peak "D" 19.6 ft
Reduced Peak "E" 16.5 ft
Discharge Cubic Feet per Second
These ordinates for Clarion and Cheat only
West Fork
Clarion
Cheat
Youghiogheny
Crooked
Loyalhanna
Allegheny
North Branch of French
Black Lick
French
Mahoning
Tionesta



Time of Arrival at Pittsburgh
AM
25th
26th
27th
28th
29th
Note: No melted snow considered
Allegheny Tributaries in solid lines.
Monongahela " " broken "
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF NOV. 27-1900 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
Reduced Peak "D"-17 most effective reservoirs.
Reduced Peak "E"-17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest.
Flood Peak 27.7 ft.
Cubic Feet per Second
Discharge
"Danger Line"
22 ft Stage
Reduced Peak "E" 13.0 ft
West Fork
Cheat
Clarion
Youghiogheny
Reduced Peak "D" 7.8 ft
Allegheny
Loyalhanna
Crooked
North Branch of French
Black Lick
French
Tionesta
Mahoning
These ordinates for Clarion and Cheat only


Time of Arrival at Pittsburgh
Note: No melted snow considered.
Allegheny Tributaries in solid lines.
Monongahela " " broken "
Reduced Peak "D"=17 most effective reservoirs.
Reduced Peak "E"=17 most effective reservoirs with volume curves flattened out.
Reservoirs not considered effective beyond capacity to dam crest
Flood Peak 28.9 ft
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
FLOOD OF MAR. 24-1898 AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE.
"Danger Line"
22 ft Stage
Reduced Peak "D" 18.4 ft
Reduced Peak "E" 18.7 ft
Discharge Cubic Feet per Second
These ordinates for Clarion and Cheat only
West Fork
Clarion
Cheat
Youghiogheny
Loyalhanna
Crooked
North Branch of French
Allegheny
Black Lick
French
Mahoning
Tionesta

The following table, No. 37, gives, under (a), for the Seventeen Selected Projects, the reduced peaks obtained by the method described under the heading of "Relative Effectiveness of Reservoir Projects," and shown in the tabulation at the bottom of Plate 69; under (b), the reduced peaks obtained from the Peak Reduction Diagrams with 17 reservoir projects only, assuming no regulation of gates at the dams; and under (c), the reduced peaks obtained using the "flattened-out" volume curves for the 17 projects.

TABLE No. 37.

FLOOD PEAK REDUCTIONS WITH THE SEVENTEEN RESERVOIRS.

Date	Mar. 20 1908	Feb. 16 1908	Mar. 15 1907	Mar. 22 1905	Mar. 4 1904	Jan. 23 1904	Mar. 1 1903	Mar. 1 1902	Apr. 21 1901	Nov. 27 1900	Mar. 24 1898	Aver. 11 floods
Flood crest	27.3	30.7	35.5	29.0	26.9	30.0	28.9	32.4	27.5	27.7	28.9	29.5
(a) Reduced gage height	13.4	14.9	27.6	19.4	18.2	19.8	18.0	20.9	13.6	8.9	18.0	17.5
(b) Reduced gage height (No control)	13.0	14.4	28.8	23.1	18.1	19.0	17.6	20.4	17.2	7.8	18.4	18.0
(c) Reduced gage height "flattened-out" (No control)	17.0	17.6	28.7	19.2	19.6	22.8	21.8	24.2	16.5	13.0	18.7	19.9
Average (b & c)	15.0	16.0	28.8	21.1	18.9	20.9	19.7	22.3	16.8	10.4	18.5	18.9

TOTAL REDUCTIONS.

(a)	13.9	15.8	7.9	9.6	8.7	10.2	10.9	11.5	13.9	18.7	10.9	12.0
(b)	14.3	16.3	6.7	5.9	8.8	11.0	11.3	12.0	10.3	19.9	10.5	11.5
(c)	10.3	13.1	6.8	9.8	7.3	7.2	7.1	8.2	11.0	14.7	10.2	9.6
Average (b & c)	12.3	14.7	6.7	7.8	8.0	9.1	9.2	10.1	10.6	17.3	10.4	10.6

A study of this table shows that the average reduced peak for the eleven floods is a gage height 0.5 foot higher under (b) than under (a). It is seen that, with a few exceptions, the results for individual floods agree closely; and, as previously noted and explained, in 7 out of 11 cases are somewhat greater under (b) than under (a), indicating the merit of the projects selected. In the 3 cases where the difference is of any considerable amount, it is in the opposite direction, and is due to the filling up of the reservoirs. These differences, 1.2, 3.7 and 3.6 feet, occurred in the case of the floods of March 15, 1907, March 22, 1905, and April 21, 1901, respectively. Inspection of the Peak Reduction Diagrams for these floods will show clearly the reason for these differences.

For example, in the flood of March 15, 1907, the Black Lick, Loyalhanna and Youghiogheny reservoirs filled before the arrival of the crest at Pittsburgh and their ordinates below the peak could not be used in obtaining the reduced gage height shown under (b).

The flood of March 22, 1905, was made up of two flood crests, the second starting soon after the first had begun to diminish, and the total flood remaining above the "danger line" 86 hours, the longest flood period at Pittsburgh on record. The Clarion, Upper Allegheny and French Creek were the principal contributors to this flood, their basins receiving the heaviest rainfall, as is readily seen by inspection of the rainfall map for this flood, on Plate 9. The Peak Reduction Diagram for this flood, Plate 75, as constructed, brings the crests of the flood volume curves of these three streams to Pittsburgh before the arrival of the second and higher peak. The Allegheny reservoirs were filled before the arrival of the second peak, so that the large reduction which could have been obtained by using the ordinate of its flood volume curve had to be thrown out, accounting for the difference between (b) and (a). The Clarion and French stor-

age was sufficient to hold their entire flood flow, but the retention of this water had a smaller effect in reducing the second peak than if the flood volume curves of these two streams had arrived at Pittsburgh later. As previously stated, however, the tributary volume curves would change their form during travel to Pittsburgh and would tend to approach the flattened form shown on the diagram; so that the storage of the French and Clarion flood waters would have a greater effect in reducing the Pittsburgh flood peak. This is the principal reason for the difference between (c) and (a) in this flood.

In the flood of April 21, 1901, the upper Allegheny Basin received a heavy rainfall, and the projects on that basin had a correspondingly large effect in reducing the Pittsburgh peak. The French and Black Lick reservoirs, however, were completely filled before the Pittsburgh peak began to recede, and therefore dropped out as factors in peak reduction; so that there was a less peak reduction at the end than at the beginning of the flood, illustrating the increase in effectiveness that may be counted upon with systematic regulation of such reservoirs. The Clarion was very effective in reducing this flood, but the Upper Allegheny, although it had a very large flood volume curve, arrived too late at Pittsburgh to bring its maximum ordinates under the Pittsburgh peak. This particular flood is noteworthy on account of the unusually heavy precipitation and run-off over all the Allegheny and a considerable part of the Monongahela Basins, most of the streams having at this time not only high discharges, but crests which occurred at such time with relation to the maximum discharge of other streams as to result in a simultaneous arrival of the tributary floods at Pittsburgh.

It will be noticed that under (c) the average resultant reduced peak for the eleven floods is gage height 19.9 feet, although there is considerable difference between the reduced gage heights for the individual floods, some being higher and some lower than previously computed under (b). It is very evident that the correct reduced gage height must lie somewhere between the figures given under (b) and (c), and the average of these two sets of figures has therefore been taken, with the following results.

The average reduced peak for the eleven floods is 18.9 feet; and in only two floods, March 15, 1907, and March 1, 1902, comes above the "danger line," or gage height 22 feet. In the case of the 1907 flood, the reduced peak, 28.8, is only 1.2 feet higher than that obtained by the original computations, summarized under (a). The reduced peak of the 1902 flood is only 0.3 foot above the 22-foot stage, and 1.4 feet above the reduced stage shown under (a).

The lower part of Table No. 37 gives the total probable reductions in feet by the various methods of computation, and it will be noted that for the averages of the eleven floods the figures vary from 9.6 feet to 12.0 feet. The average of (b) and (c) methods gives 10.6 feet and makes possible a general statement that, with the Seventeen Selected Projects in operation, it would not be unreasonable to assume a probable reduction of 10 feet in gage height at Pittsburgh for any flood that may occur.

POSSIBLE MAXIMUM FLOOD AT PITTSBURGH.

As a means of arriving at some approximate estimate of the possible maximum stage which could be expected at Pittsburgh in the future in the event of simultaneous conditions of temperature and precipitation favorable to a high rate of run-off on the basins of the two rivers, an estimate has been made of the amount of snow which may reasonably be expected to remain on the ground on the first of March at the end of a winter of excessive snowfall, similar to that of 1909 and 1910, and this snow has been assumed to melt and run off with a rainfall which actually occurred. The rain storm of March 4, 1904, was selected for this purpose, as there was no snow on the

ground at this time and the flood stage of 26.9 at Pittsburgh was therefore due to rainfall alone. The amount of snow assumed to run off with this rainfall was as follows: North of the Mahoning Creek watershed, 30 inches; between Mahoning Creek and the southern extremity of the Loyalhanna watershed, 24 inches; south of this point, 18 inches. A detailed discussion of this snowfall is to be found in Chapter III of this report.

Plate 83 shows a graphical study of the possible maximum flood under the above conditions. The flood volume curves for the various streams represent the run-off due to rain and snow combined, and are obtained by adding the additional run-off due to the assumed amount of melted snow to the corresponding rainfall flood volume curves of Peak Reduction Diagram, Plate 59, for the flood of March 4, 1904. The sum of the ordinates under the peak on Plate 83 was then reduced by the sum of the ordinates at a similar point on Plate 59, representing rain only. The result, representing increase in stage due to melted snow, was then added to the actual flood peak of 26.9, giving a stage of 38.3. This, of course, represents the increased flood peak considering snow run-off from only 62 per cent of the drainage area; so that if the entire drainage area had been considered, it is reasonable to suppose that the estimated flood height would have been considerably higher.

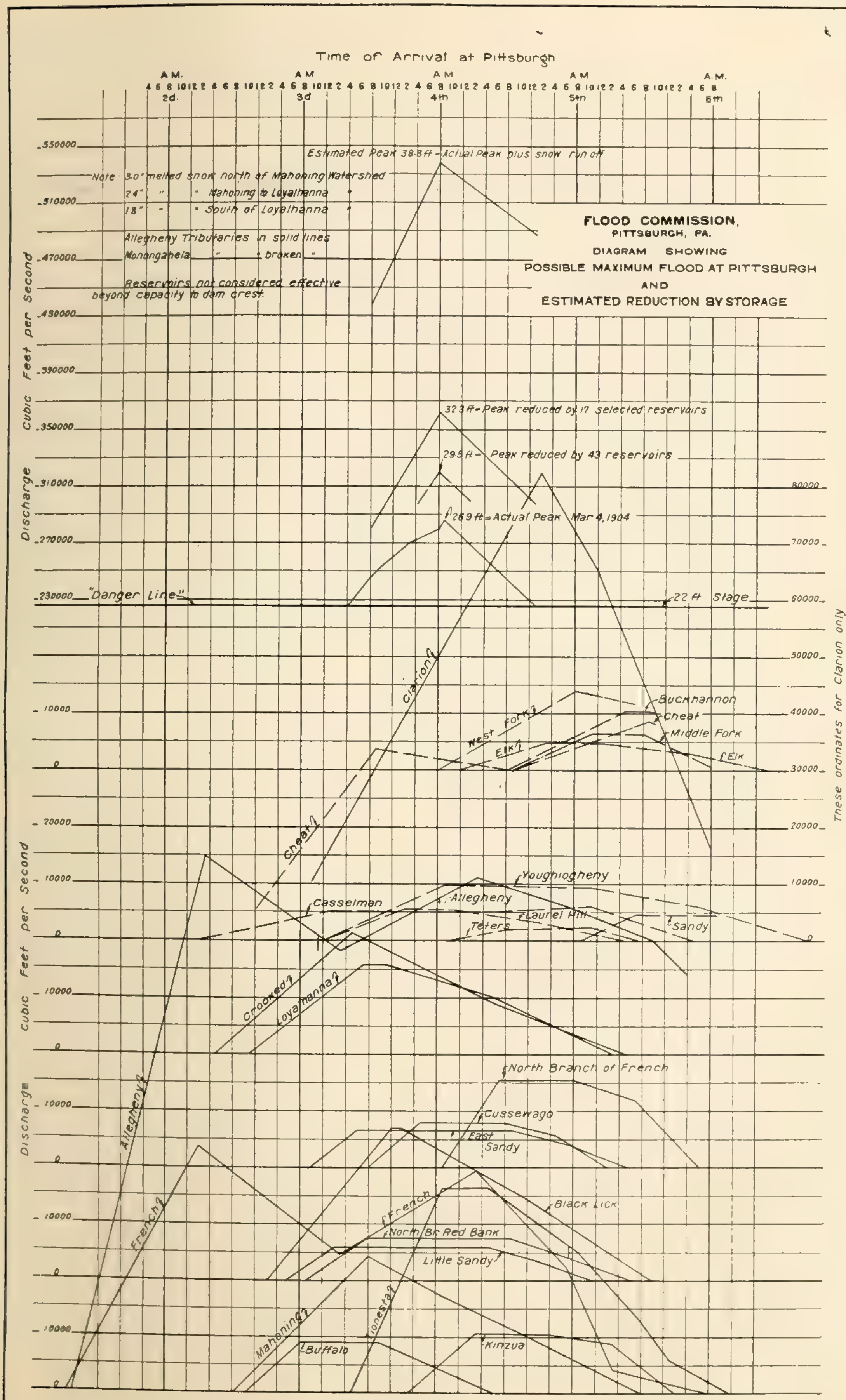
The Seventeen Selected Projects, if no regulation were considered, would have reduced this flood from 38.3 to 32.3. With regulation, the seventeen projects could probably have reduced the stage to 30 feet or under, for the French Creek, Black Lick and Allegheny reservoirs were filled before the arrival of the peak at Pittsburgh, and suitable regulation on the Black Lick alone would have lowered the reduced peak from 32.3 to 30.8. The 43 projects, with no regulation, could have lowered the peak to 29.5 feet.

CONCLUSION.

As already stated, the reservoirs used at this time for purposes of estimate and study are based on present conditions and are subject to revision. Additional stream-flow data, detailed surveys and estimates preceding actual construction, future economic developments and the addition of duties other than that of flood control, would doubtless, in the final working-out of the system, necessitate many changes in the number, location and capacities of reservoir projects.

The estimates and studies based on the surveys of the sites as selected are sufficient, however, to demonstrate the fundamental and vital points, namely: that floods can be prevented by storage reservoirs; that suitable sites for these reservoirs can be found; and that the cost of their construction would be but a comparatively small percentage of the benefits to be derived, not only through positive and permanent flood relief, but also from the facilitation of interstate commerce by the improvement of the rivers for navigation, from the considerable dilution of their polluted waters and the consequent increase in their value for domestic and industrial supply, and from the development of water power.

The studies of the Flood Commission, moreover, have not only demonstrated the necessity for such works upon the Allegheny and Monongahela Basins, but have shown the wisdom of having similar studies made on the streams where floods are a menace in this and other States. In this connection the Commission desires to emphasize the importance of systematic and complete collection and studies of rainfall and stream-flow data, both of which are vitally essential in investigations of this kind. In order that long-term records of such data may be available for preliminary and final studies, plans


Time of Arrival at Pittsburgh
A.M.
2d.
3d
4th
5th
6th
Estimated Peak 38.8 ft = Actual Peak plus snow run off
Note 3.0" melted snow north of Mahoning Watershed
2.4" " " Mahoning to Loyalhanna "
1.8" " " South of Loyalhanna "
Allegheny Tributaries in solid lines
Monongahela " broken "
Reservoirs not considered effective beyond capacity to dam crest
FLOOD COMMISSION,
PITTSBURGH, PA.
DIAGRAM SHOWING
POSSIBLE MAXIMUM FLOOD AT PITTSBURGH
AND
ESTIMATED REDUCTION BY STORAGE
32.3 ft = Peak reduced by 17 selected reservoirs
29.5 ft = Peak reduced by 43 reservoirs
26.9 ft = Actual Peak Mar 4, 1904
"Danger Line"
22 ft Stage
Discharge Cubic Feet per Second
These ordinates for Clarion only
Clarion
Buckhannon
Cheat
Middle Fork
Elk
West Fork
Youghiogheny
Allegheny
Casselman
Laurel Hill
Teters
Sandy
Crooked
Loyalhanna
North Branch of French
Cussewago
East Sandy
Black Lick
French
North Br Red Bank
Little Sandy
Mahoning
Tionesta
Buffalo
Kinzua

and estimates, State and Federal agencies in charge of such work should be provided with ample funds. The water resources of the country are one of its greatest assets, but they can never be properly utilized, or their various uses coordinated, unless proper data for this purpose are on record.

CHAPTER VIII.

FLOOD PROTECTION.

Dredging—Lowering of High-water Plane, Flood of 1907—Effect of Navigation Dams—Quantities and Costs of Dredging—River Wall—Seepage—Location of Wall—Quantities and Costs of Various Wall Schemes—Land Reclaimed by Wall — Net Cost of Various Schemes of Flood Relief—Channel Revisions at Islands—Final Summary of Cost of Flood Relief—Discussion.

DREDGING.

The problem of the local control of floods by dredging has been divided into two projects, Grade No. 1 and Grade No. 2, as shown on the profile, Plate 84, and as later described. With each grade the dredging is figured in two ways, with the wall located along the natural bank line, and with the wall located along the standard cross-section.*

In the case of the wall along the natural bank line, the sides of the channel are cut out on a 3 to 1 slope from the intersection of pool-full plane with the banks down to the dredging grade, except that where the wall stands out from the bank and in the pool, the 3 to 1 slope starts at the intersection of the face of the wall with the river bottom. With the wall along the standard cross-section, the dredging includes in general cutting the side slopes on a 3 to 1 slope from the intersection of the face of the wall with pool level, or with the river bottom if below pool level, down to the dredging grade. At certain narrow points, and along Duquesne Way, the dredging is carried down to 10 feet below pool level at the face of the wall, and from here slopes away from the wall on a 3 to 1 slope down to dredging grade; in the former case to give as much cross-sectional area as possible, and in the latter, for navigation purposes as well. It may be that additional points where docking facilities will have to be provided in this way will be decided upon during detailed design and before actual construction of the wall, but for the purposes of the present estimate it is considered unnecessary to go into a study of this feature. Again, along other stretches, the bank is already protected by paving, as along portions of the B. & O. and P. & L. E. railroads, and only a comparatively low additional flood barrier is needed in the shape of a low wall at the top of the slope. At these points the side slopes are cut out on a 3 to 1 slope from the intersection of pool level with the present bank down to dredging grade.

PROJECT NO. 1.

The dredging proposed with Grade No. 1 contemplates cutting channel bottom and side slopes from a point about 1.6 miles above the Davis Island dam on the Ohio to Dams No. 1 on the Allegheny and Monongahela Rivers. On the Allegheny the dredging continues on a steeper grade above Dam No. 1 to a point about a mile below Dam No. 2. When combined with the wall located along the natural bank line, the dredging terminates here; but with the other wall location, along the standard cross-section, the dredging continues upstream to Dam No. 2. On the Monongahela, likewise, with the wall along the natural bank line, the dredging to this grade terminates at Dam No. 1, but with the other wall location, continues above the dam to the upper end of the present surveys, a short distance above the B. & O. R. R. bridge at Glenwood.

The elevation of Grade No. 1 at its downstream terminus is 687 feet, or 16 feet below pool level, and from here it extends upstream with a .0002 slope, reaching an elevation of 692, 5 feet below the navigable pass sill, at Dam No. 1, Allegheny, and an elevation of 692.3, 1.4 feet below the lower lock sill, at Dam No. 1, Monongahela.

*See "Location of Wall," page 204.

Above Dam No. 1 on the Monongahela, the slope continues unchanged; but on the Allegheny above Dam No. 1, the river bed having in general a greater slope than below the dam, the dredging grade changes to .0003, reaching an elevation of 700.4 at Dam No. 2, 1.4 feet above the lower lock sill, and 9.6 feet below pool level.

Grade No. 1 at its lower end approximately intersects the average bottom of the channel cross-section as determined by the soundings of the Flood Commission made in 1909. It requires no considerable cutting of the river bed below the foot of Brunot Island; from which point upstream to about 1000 feet above the head of the island, however, there is an average cutting of 5 feet. The remainder of the Ohio channel to the Point requires very little dredging other than the cutting of the side slopes.

In the case of the wall location eliminating the Brunot Island back channel there is of course no dredging figured in the back channel. With the other wall location, however, the lower 1200 feet of this back channel are dredged and the contraction at the mouth is widened from 520 to 630 feet by cutting out the left bank at the McKees Rocks quarry.

In the Allegheny River, 1500 feet below Dam No. 1, the cutting averages 2 feet for a length of 1500 feet. Above the dam, three separate stretches are dredged. The first of these, lying between the dam and the 30th Street bridge, is about 2000 feet long and has an average depth of 2 feet; the second centers about at the 43rd Street bridge, and is about 6000 feet long and an average of 4 feet deep; the third extends from the Sharpsburg bridge downstream about 6000 feet and has an average depth of 4 feet. At the Sharpsburg bridge the grade line emerges from the last of these cuts and coincides with the present transverse average bottom of the river for a distance of about half a mile; in the case of the wall located along the natural bank line terminating 2500 feet beyond, about a mile below Dam No. 2, while with the other wall location the cutting extends to Dam No. 2.

On the Monongahela, at about 500 feet above the Point bridge, the dredging passes into a cut of 3.5 feet average depth, about 1.5 miles long, reaching to within one-half mile of Dam No. 1. With the wall along the natural bank line, the dredging terminates here, but with the other wall location, requiring dredging, it continues on the same grade to the end of the project, about 1.2 miles below the extreme easterly north and south city boundary line. There is an average cut of 2 feet for about 1.2 miles above Dam No. 1, and a second cut, with an average depth of 2.5 feet, begins about 1000 feet below Glenwood bridge and extends for one-half mile to the end of the project, about 800 feet above the B. & O. R. R. bridge.

PROJECT NO. 2.

The grade of dredging of Project No. 2 begins in the Ohio River at a point 15,180 feet below Davis Island dam, and 7500 feet above Dam No. 2, at an elevation of 678.6. The grade line extends with a slope of .0002 up the main channel only, at Neville Island, the back channel remaining unimproved, and passes Dam No. 1 at an elevation of 681.6, 9.4 feet below the navigable pass sill, elevation 691.0; 1.5 feet below the land wall foundation, elevation 683.1; and 5.5 feet below the river wall foundation, elevation 676.1. The grade line follows the main channel at Brunot Island and the back channel to a point 1200 feet from the main channel. The same enlargement of the mouth of the back channel is contemplated as with Project No. 1. With the wall located along the standard cross-section, there would of course be no dredging in the back channel.

At Dam No. 1, Allegheny River, the grade line has an elevation of 688.3, passing 6.7 feet below the lower sill, elevation 695.0, and 8.7 feet below the navigable pass sill

elevation 697.0. Up to this point the grade line lies parallel to that of Project No. 1 and 3.7 feet below it, but beyond continues with the slope of .0002 unchanged to the end of the project at Dam No. 2, Allegheny River, where the elevation at grade is 693.9, a depth of 5.1 feet below the lower lock sill, elevation 699.0; 17.1 feet below the upper lock sill, elevation 711.0; and 6.5 feet below grade of Project No. 1, elevation 700.4, the depth below the grade of that project between the two dams averaging 5.1 feet.

In the Monongahela River the grade line lies parallel to and 3.7 feet below that of Project No. 1 and passes Dam No. 1 at an elevation of 688.6, 5.1 feet below the lower lock sill, elevation 693.7; 11.8 feet below the upper lock sill, elevation 700.4; and 18.8 feet below pool full, which in this case is crest of fixed dam, elevation 707.4. The grade line continues parallel to grade of Project No. 1 to the end of the project, about 800 feet above the B. & O. R. R. bridge, Glenwood, where the elevation at grade is 693.2.

LOWERING OF HIGH-WATER PLANE, FLOOD OF 1907.

Project No. 1.

The cutting of side slopes at the section 1.6 miles above Davis Island dam, where the Grade No. 1 dredging begins, does not cause an immediate lowering of the high-water plane at that section, for in that case the surface slope in the channel below due to such lowering would be less than .00022, which is required for discharge through the cross-section of this part of the channel. The improvement beginning at this section, which involves cutting the side slopes only and thus increasing the sectional area, does, however, allow the full discharge at the unlowered level with a lower surface slope of approach. This lower slope of approach is .00021, and a uniform width of channel at Brunot Island permits a continuation of this rate as far as the lower Allegheny River, the intermediate narrow sections all discharging with this surface slope, at the corresponding reduced water levels. This results in lowering the high-water plane 1.4 feet at a point 500 feet below the Ohio Connecting bridge, 0.9 foot at a point 1000 feet above the head of Brunot Island, and 2.3 feet at a point on the Allegheny about midway between the Point and the 6th Street bridge.

At this point on the Allegheny the required slope of approach is only .00014 and increases to .00016 at a point about 500 feet above the 30th Street bridge, where by cutting the sides and bottom of the main channel, and in the case of the wall along natural bank line, of the back channel as well, the high-water stage is reduced 2.7 feet. The surface slope of .00016 is sufficient from the latter point to the section about midway between the 43rd Street bridge and McCandless Avenue, where the high-water level in consequence of the slope of .00016 required for the sections below, will have to be 733.0, a lowering of 2.4 feet. At this cross-section the width between banks at pool level is considerably less than at any other section of the Allegheny within the projects. With the cutting of both banks included in the dredging, the discharge through this section at the lowered water level requires a slope of .0002 upstream to a point near the Sharpsburg bridge, where the reduction of high-water surface is 2.1 feet. By cutting the side slopes only at the latter section, and both the sides and bottom of the channel from this point upstream to the end of the project, about a mile below Dam No. 2, the lowered high-water plane at its upper end has a reduced slope of .00014. The surface of the high water from where it passes over Dam No. 2 slopes abruptly to the point where the dredging project terminates, and the reduction that would be effected in this stretch by carrying the dredging to Dam No. 2 would not be sufficient to warrant the work. In the case of the wall along the standard cross-section, however, the dredging

has been extended upstream to the dam in order to obtain the adopted area of cross-section.

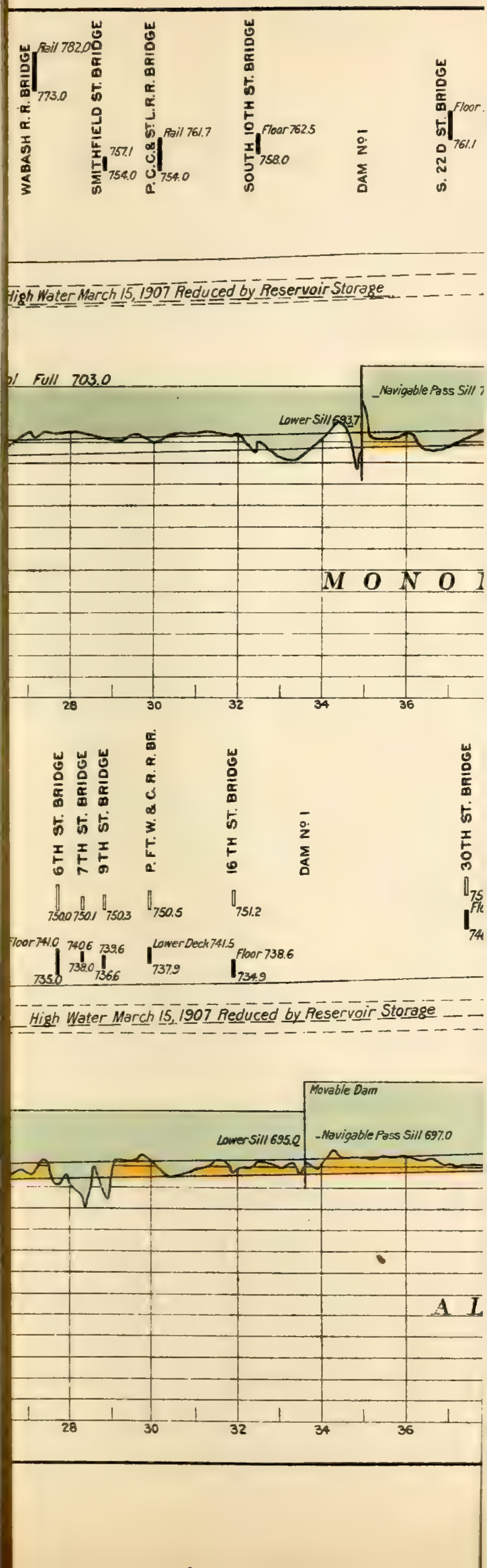
On the Monongahela River the high-water surface slope of .00021 continues from the Ohio River to a point about 700 feet below the Wabash Railroad bridge, where a reduction of 2.3 feet is effected. Owing to the removal of considerable river bottom and embankment, the required high-water slope above this point reduces to .00018; 1150 feet upstream, further reduces to .00016; and diminishes to .00014 at a section 650 feet above the P., C., C. & St. L. Ry. bridge. This .00014 slope extends upstream to a point about 350 feet above the South 10th Street bridge, where the reduction of high-water level is 2.3 feet. From this point the required slope increases to .00024, extending to about 1000 feet below Dam No. 1. Above the dam, the slope averages in general .000135, the reduction of flood level corresponding to this slope being 2.3 feet at Dam No. 1 and 2.7 feet at a point about midway between the Monongahela Connecting R. R. bridge and the Glenwood bridge. At this section the surface slope changes to .0002, lowering the high-water plane an average of about 2 feet between this point and the end of the project, where the reduction is 2.5 feet.

Project No. 2.

The lowering of the high-water plane due to dredging to Grade No. 2 begins theoretically at a point about 2.9 miles below the Davis Island dam, where the improvement of the side slopes of this controlling cross-section allows the discharge of the maximum flow during the 1907 flood at a lowered slope of approach. With this slope of .00013, the dredging of the channel bottom from this point upstream provides sectional areas of sufficient carrying capacity for the required discharge in all portions of the channel to a point about 4100 feet above Davis Island dam, where the reduction in flood height due to this reduced slope amounts to 1.2 feet. It is not necessary to dredge the back channel at Neville Island, as the controlling cross-sections have sufficient carrying capacity to discharge at the lowered stages obtained in the main channel.

Beginning at the above mentioned point, about 4100 feet above Davis Island dam, the narrowing of the river, notwithstanding considerable dredging of its bottom, requires a slightly increased high-water slope of .00018 extending to the foot of Brunot Island, where the flood profile is lowered 1.4 feet. Above this section the slope necessary for discharge increases to .00021, which extends beyond the mouth of the Allegheny River to a point about midway between the Point and the Sixth Street bridge, where the reduction is 3.7 feet. From this point on the Allegheny the required slope is .00011 upstream to the P., F. W. & C. Ry. bridge, where the stage is lowered 3.9 feet. The slope then increases slightly to .000125, extending at this rate to the narrow portion of the river between the 43rd St. bridge and McCandless Ave., and effecting a reduction of 4.4 feet in the flood stage at this narrow section. From here there is an abrupt increase in the slope to .00021, this required slope reaching to the Sharpsburg bridge, where it reduces to .00011, extending at this rate to the end of the project, where the flood stage is lowered 4.0 feet. The maximum reduction is 4.5 feet, at a point about midway between the 30th Street bridge and the Junction R. R. bridge.

In the Monongahela River the high-water slope from the Ohio River extends to a point about 700 feet below the Wabash Railroad bridge, where the flood stage is lowered 3.7 feet; and then decreases gradually to .00016, extending at this rate for about 1200 feet, and effecting a reduction of 3.6 feet at a point 500 feet above the Wabash bridge. From here it changes to .00014, extending to a point about 600 feet above the P., C., C. & St. L. Ry. bridge, and lowering the flood stage at this point 3.5 feet. A slope of



WABASH R. R. BRIDGE
Rail 782.0
773.0
SMITHFIELD ST. BRIDGE
757.1
754.0
P. C.C.& St. L.R.R. BRIDGE
Rail 761.7
754.0
SOUTH 10TH ST. BRIDGE
Floor 762.5
758.0
DAM Nº 1
S. 22 D ST. BRIDGE
761.1
High Water March 15, 1907 Reduced by Reservoir Storage
Full 703.0
Navigable Pass Sill
Lower Sill 693.7
M O N O
28
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32
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36
6TH ST. BRIDGE
7TH ST. BRIDGE
9TH ST. BRIDGE
P. FT. W. & C. R. R. BR.
16 TH ST. BRIDGE
DAM Nº 1
30TH ST. BRIDGE
750.0
750.1
750.3
750.5
751.2
Floor 741.0
740.6
739.6
738.0
735.0
736.6
Lower Deck 741.5
737.9
Floor 738.6
734.9
High Water March 15, 1907 Reduced by Reservoir Storage
Movable Dam
Lower Sill 695.0
Navigable Pass Sill 697.0
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On the Monongahela River the high-water surface slope of .00021 continues from the Ohio River to a point about 700 feet below the Wabash Railroad bridge, where a reduction of 2.3 feet is effected. Owing to the removal of considerable river bottom and embankment, the required high-water slope above this point reduces to .00018; 1150 feet upstream, further reduces to .00016; and diminishes to .00014 at a section 650 feet above the P., C., C. & St. L. Ry. bridge. This .00014 slope extends upstream to a point about 350 feet above the South 10th Street bridge, where the reduction of high-water level is 2.3 feet. From this point the required slope increases to .00024, extending to about 1000 feet below Dam No. 1. Above the dam, the slope averages in general .000135, the reduction of flood level corresponding to this slope being 2.3 feet at Dam No. 1 and 2.7 feet at a point about midway between the Monongahela Connecting R. R. bridge and the Glenwood bridge. At this section the surface slope changes to .0002, lowering the high-water plane an average of about 2 feet between this point and the end of the project, where the reduction is 2.5 feet.

Project No. 2.

The lowering of the high-water plane due to dredging to Grade No. 2 begins theoretically at a point about 2.9 miles below the Davis Island dam, where the improvement of the side slopes of this controlling cross-section allows the discharge of the maximum flow during the 1907 flood at a lowered slope of approach. With this slope of .00013, the dredging of the channel bottom from this point upstream provides sectional areas of sufficient carrying capacity for the required discharge in all portions of the channel to a point about 4100 feet above Davis Island dam, where the reduction in flood height due to this reduced slope amounts to 1.2 feet. It is not necessary to dredge the back channel at Neville Island, as the controlling cross-sections have sufficient carrying capacity to discharge at the lowered stages obtained in the main channel.

Beginning at the above mentioned point, about 4100 feet above Davis Island dam, the narrowing of the river, notwithstanding considerable dredging of its bottom, requires a slightly increased high-water slope of .00018 extending to the foot of Brunot Island, where the flood profile is lowered 1.4 feet. Above this section the slope necessary for discharge increases to .00021, which extends beyond the mouth of the Allegheny River to a point about midway between the Point and the Sixth Street bridge, where the reduction is 3.7 feet. From this point on the Allegheny the required slope is .00011 upstream to the P., F. W. & C. Ry. bridge, where the stage is lowered 3.9 feet. The slope then increases slightly to .000125, extending at this rate to the narrow portion of the river between the 43rd St. bridge and McCandless Ave., and effecting a reduction of 4.4 feet in the flood stage at this narrow section. From here there is an abrupt increase in the slope to .00021, this required slope reaching to the Sharpsburg bridge, where it reduces to .00011, extending at this rate to the end of the project, where the flood stage is lowered 4.0 feet. The maximum reduction is 4.5 feet, at a point about midway between the 30th Street bridge and the Junction R. R. bridge.

In the Monongahela River the high-water slope from the Ohio River extends to a point about 700 feet below the Wabash Railroad bridge, where the flood stage is lowered 3.7 feet; and then decreases gradually to .00016, extending at this rate for about 1200 feet, and effecting a reduction of 3.6 feet at a point 500 feet above the Wabash bridge. From here it changes to .00014, extending to a point about 600 feet above the P., C., C. & St. L. Ry. bridge, and lowering the flood stage at this point 3.5 feet. A slope of

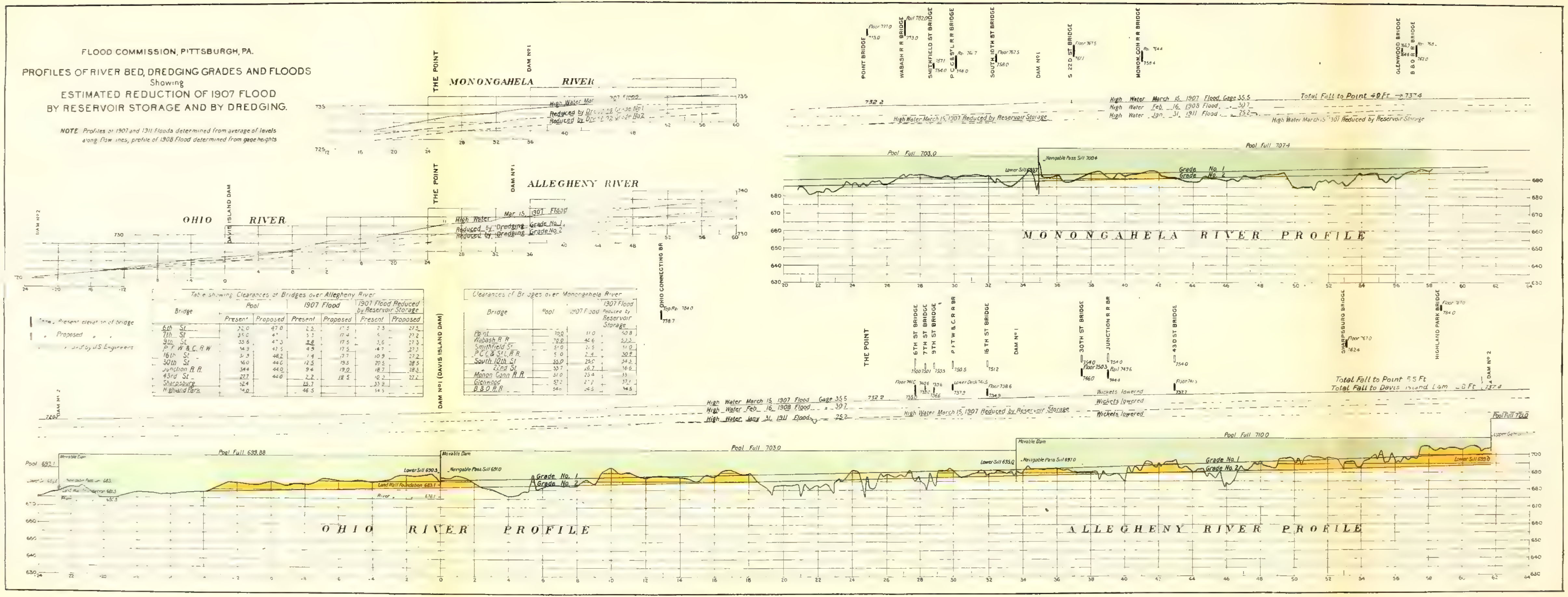


Table showing Clearances of Bridges over Allegheny River

Bridge	Pool		1907 Flood		1907 Flood Reduced by Reservoir Storage	
	Present	Proposed	Present	Proposed	Present	Proposed
6th St	[illegible]	47.0	2.5	17.5	2.5	27.5
7th St	35.0	[illegible]	5.3	17.4	5	27.2
9th St	33.6	47.3	3.8	17.5	3.6	27.3
P. F. W. & C. R. W.	34.3	47.5	4.9	17.5	4.7	27.3
16th St	[illegible]	48.2	1.4	17.7	10.9	27.2
30th St	36.0	44.0	12.5	19.5	20.5	28.5
Junction R. R.	34.4	44.0	9.4	19.0	18.7	28.3
43rd St	27.7	44.0	2.2	18.5	10.3	27.2
Sharpsburg	52.4		25.7		33.9	
Highland Park	74.0		46.5		54.5	

Clearances of Bridges over Monongahela River

Bridge	Pool	1907 Flood	1907 Flood Reduced by Reservoir Storage
Point	70.0	31.0	50.8
Wabash R. R.	70.0	42.6	53.3
Smithfield St	51.0	21.5	31.0
P. C. C. & St. L. R. R.	[illegible]	21.4	30.9
South 10th St	55.0	25.0	34.3
22nd St	53.7	26.7	36.6
Monon Conn R. R.	51.0	23.4	[illegible]
Glenwood	57.2	27.2	37.1
B. & O. R. R.	[illegible]	24.5	34.5

.00011 is required from here upstream to a point about 2000 feet below Dam No. 1, where the stage is lowered 3.8 feet. The required slope is then .000135 to the end of the project. About midway between the Monongahela Connecting R. R. bridge and the Glenwood bridge, the stage is lowered 4.5 feet, and at the end of the project, the reduction is 4.2 feet.

EFFECT OF NAVIGATION DAMS.

Project No. 1.

The above described reduction of high-water plane by dredging to Grade No. 1 is figured as if Dams No. 1, Allegheny and Monongahela, were not in place; but the reductions upstream from the dams could not be obtained as described unless the dams were rebuilt with the required sections and sill elevations.

The backwater influence of Dam No. 1, Allegheny River, produces throughout the entire dredging project upstream from the dam, a surface curve corresponding to the 1907 high-water plane as nearly as can be determined under the uncertain conditions of non-uniform flow in the varying cross-sections above the dam. In other words, with the dam as it is, dredging to Grade No. 1, as proposed above the dam, would have little or no lowering effect on the high-water profile.

In the Monongahela River also, the full value of the dredging above the dam cannot be obtained with Dam No. 1 in its present position, as this obstruction produces a surface curve of backwater coinciding in general with the 1907 high-water profile to a point 5000 feet above the dam and from there dropping to 0.8 foot below the 1907 flood level at a point about 2.5 miles above the dam, and continuing with about this amount of reduction to the upstream end of the project.

Project No. 2.

The above described lowering of the 1907 flood profile by dredging to Grade No. 2 is figured as if Dams No. 1, Ohio, Allegheny and Monongahela, were not in place. The cross-section at Dam No. 1, Ohio, with wickets lowered, has sufficient discharge capacity to accommodate the flood flow without appreciably diminishing the reduction of high-water plane obtained by dredging to Grade No. 2. Dams No. 1, Allegheny and Monongahela, however, as now located, would have a backwater effect with this dredging, which would diminish the above described reductions of the 1907 flood profile upstream from the dams to 1.4 feet on the Allegheny and 1.6 feet on the Monongahela.

The profile, Plate 84, shows the lowering of high-water plane for the two grades, assuming the dams removed, or rebuilt with the required sections and sill elevations.

QUANTITIES AND COSTS.

Project No. 1.

Dredging to Grade No. 1, with the wall along the natural bank line, involves the removal of 1,180,900 cubic yards on the Ohio, 2,124,000 cubic yards on the Allegheny and 483,600 cubic yards on the Monongahela; a total of 3,788,500 cubic yards. In addition, the enlargement of the mouth of Brunot Island back channel would require the removal of about 95,000 cubic yards, chiefly rock, excavation of which has been figured at one dollar per cubic yard. Dredged material could be readily and cheaply disposed of as fill behind the wall, and the dredging of the channel has been figured at 20 cents per cubic yard. The total cost with these unit prices would therefore amount to $852,700.

With the wall along the standard cross-section, dredging to Grade No. 1 requires the removal of 4,007,100 cubic yards on the Ohio, 4,505,000 cubic yards on the Alle-

gheny and 3,907,900 cubic yards on the Monongahela; a total of 12,420,000 cubic yards. 6,888,000 cubic yards of this work would be channel excavation, and the remainder, 5,532,000 cubic yards, would be involved in the changes at the three islands. The former has been figured at 20 cents and the latter at 25 cents per cubic yard, giving a total cost of $2,760,600.

Project No. 2.

Dredging to Grade No. 2, with the wall along the natural bank line, involves the removal of 6,745,400 cubic yards on the Ohio, 4,055,800 cubic yards on the Allegheny and 3,998,300 cubic yards on the Monongahela; a total of 14,799,500 cubic yards, which at 20 cents per cubic yard would amount to about $2,959,900. The enlargement of the mouth of Brunot Island back channel would also be included in this project, and figuring $95,000 for this work as with Project No. 1, the total cost of Project No. 2, *exclusive* of any of the above mentioned necessary changes at the navigation dams, would amount to $3,054,900.

With the wall along the standard cross-section, dredging to Grade No. 2 requires the removal of 11,523,200 cubic yards on the Ohio, 8,444,300 cubic yards on the Allegheny and 6,711,500 cubic yards on the Monongahela; a total of 26,679,000 cubic yards. 5,532,000 cubic yards of this work would be excavation of the strips cut off the three islands, which work, as under Project No. 1, has been figured at 25 cents per cubic yard, while the channel excavation as before has been figured at 20 cents. The total cost of this work, *exclusive* of necessary changes at the navigation dams, would therefore amount to $5,612,400.

RIVER WALL.

TYPE AND DESIGN.

For the purposes of this estimate a gravity section constructed of concrete was selected. This was designed as a submerged section, owing to the possibility of seepage beneath and the presence of accumulated ground water behind the wall. The top of the wall would carry a solid concrete parapet 3.5 feet high, all necessary openings in which would be provided with stop planks, or other suitable means of closing during high water.

The typical wall sections used in the estimates have been figured generously as to quantities and unit costs to compensate for special features which it would be necessary to include in final designs, but which it is considered should not be estimated upon in detail in this preliminary study. These special features would include numerous openings in the wall for access to the river front, such as steps, landings, slips, ramps, etc., together with devices for closing such openings during floods. Convenient arrangements must also be made for mooring, and for loading and unloading river craft. The probable construction of intercepting sewers in a considerable portion of the walls, with sumps and sewage pumping works, has been considered as to feasibility of application, but the cost of such work has not been included in the estimates.

FOUNDATION.

To determine the depth to rock and the character of the overlying material for the purpose of fixing the foundation of the wall for estimate purposes, a collection was made of all available data, including well-borings and information with regard to the foundations of bridge piers, buildings, locks and dams. The amount of this information at points along the proposed wall line is not complete enough to be thoroughly satisfactory, as

it was necessary to interpolate depths to rock and gravel bed at points where no such data existed. Before actual construction is begun a careful set of borings should be made along the line of the wall, but it did not seem wise to expend the time and money upon such investigation at this time. From the data on hand, however, it is evident that the depth to rock is too great to permit carrying the wall down to rock footings and therefore the estimates are based on its being founded on the bed of gravel and clay overlying the rock.

The depths to bed rock below surface of the pools at Pittsburgh, as approximately determined, may be given as follows: foot of Brunot Island, 40 feet; opposite center of this island, 25 feet; near mouth of Saw Mill Run, 45 feet; at the head of the Ohio, in the mouth of the Allegheny, about 40 feet. One mile up the Allegheny it reaches a depth of 60 feet, from which place it seems to rise rather suddenly for a distance of 0.7 mile and then ascends gradually to a point 3.5 miles above the mouth of the river, where the depth is 30 feet below surface of pool No. 1. Six miles from the mouth, the rock is about 15 feet below water, and from here it has a moderately undulating surface to Lock No. 2. At the mouth of the Monongahela, the rock is about 40 feet below pool, one mile above it is 60 feet below, and 3.2 miles, 40 feet. From here upstream there appears to be a gradual rise.

EXCAVATION AND EMBANKMENT.

It is not considered that this paper location of the wall furnishes data sufficiently detailed to admit of any refinement in the computation of the necessary excavation and embankment. A certain amount of earthwork has been arbitrarily estimated upon, however, and is included in the cost per running foot. Where the wall stands out from the bank some distance, the backfill will be considerably greater in amount; but it is intended to include in this estimate only sufficient backfill to protect the back of the wall, it being understood that the remaining embankment necessary to bring the land back of the wall up to the grade of the top of the wall will rapidly be filled in with excavated materials, slag, ashes and other wastes, convenient spoil and dumping grounds for which are at a premium in this locality. When a final location of this wall is adopted, however, and staked out on the ground for actual construction, the field notes then obtained will of course furnish the data necessary for a more accurate earthwork estimate.

SEEPAGE.

With the wall founded on the permeable material overlying the rock there is almost certain to be seepage under the wall. In the case of the wall with reservoir control, (low wall), and consequently a *lower head* to force this water under the wall, this seepage will be so slight and so infrequent as to be negligible. But with the wall without reservoir control, (high wall), this seepage will be so important a consideration that, in order to afford complete flood protection, the wall design and estimate must include some cut-off or curtain wall running from the foundation down to solid rock or to impermeable material.

Cut-off Wall.

The only way to be positive of absolutely preventing all seepage would be to sink an open trench to rock, and put in a concrete core-wall under the retaining wall. The expense of such a method would obviously be prohibitive and unwarranted, as a sufficient prevention of seepage can be obtained at a much less cost.

Sheet Piling.

Seepage could also be prevented, or reduced to a minimum, by driving sheet piling

under or along the wall. If this sheet piling is driven before the wall is built, it should be at or near the outer face, where, in the event of any settlement of the wall, or outward thrust, it would tend to prevent overturning rather than the reverse, which might be the case were it at the center or back of the wall. It could be driven at the toe of the wall, and used as the cofferdam on that side during construction, its upper part being finally bonded into the wall section. It is not certain, however, that sheet piling will be needed to prevent seepage; for the wall, when carried down to a suitable footing, may effectually prevent this. At any rate, it is impossible to determine with certainty beforehand just where sheet piling is required; and if one of the above methods is used, a great deal of unnecessary piling might be driven. It would seem wise, therefore, to build the wall without sheet piling, and then by observations on the seepage during the first flood after construction, decide what sections, if any, should have piling. It could then be driven along the toe of the wall a short distance out from the wall, and the space between sealed with concrete. Several types of sheet piling are in general use for work of this kind, and their relative merits and suitability under the conditions obtaining are as follows:

Wood. Wooden sheet piling would be the cheapest, costing about $0.60 per square foot, and would doubtless have a longer life than that of steel. It would be difficult, however, in the character of material along the river front, to drive to the necessary depth, and this form is not considered advisable.

Reinforced Concrete. Reinforced concrete sheet piling would be the most durable and, at the same time, the most expensive, costing about $1.50 per square foot. It is possible that by careful driving it might be satisfactorily placed, but in places there would unquestionably be great difficulty in keeping it in line down to the necessary depth.

Steel. Interlocking steel sheet piling could be driven to the desired depth with greater certainty of proper alignment than any other form. It would be more expensive than wooden piling, costing about $1.00 per square foot in place. It would form an excellent cut-off wall during its life, but there is possibility of its disintegration due to attack by acid water and to electrolysis. It might be protected with a suitable coating to prevent this trouble, but is hardly likely that it could be successfully driven without scraping such a coating off during the operation. Suitable tests might demonstrate, however, that with the piling imbedded in the gravel and clay of the river bank, corrosion would be reduced to a negligible minimum. The following estimates are based on the use of this type of piling.

LOCATION OF WALL.

The wall problem has been thoroughly studied, both as the *only* means of flood relief, and in combination with *other* methods of Flood Protection and Flood Prevention. These various methods of treatment have been classified under two general headings: Wall along natural bank line; Wall along standard cross-section.

WALL ALONG NATURAL BANK LINE.

This location follows in general the natural bank line except at certain indentations and projections, to conform to which would give a very irregular alignment. At indentations, where the wall stands out from the natural bank, it is of course higher and more costly than if it followed the bank line; but in many cases the value of the reclaimed land behind the wall at such points will offset the greater cost of construction. At certain slight indentations of this sort, where the top of the natural bank is above the maximum flood level, no wall has been considered necessary; but property owners at

such points, who so desire, could construct their own wall and reclaim the land behind it. In such cases the type, height and alignment of wall should conform to the general scheme, and the work should be bonded into the flood wall. Again, at certain low points, where the bank is only a foot or two below maximum flood height, no wall has been considered necessary, as the ground can easily be raised an amount sufficient to prevent overflow. At some of these points where no wall is needed to prevent actual overflow, however, it will probably be necessary to drive sheet piling to keep out seepage.

To prevent backwater overflow it will also be necessary to carry the wall some distance up the several small streams entering the main rivers in the vicinity. A very large portion of the backfill behind the wall could be placed without cost as waste material, such as excavated material, ashes and slag, becomes available; but certain sections, as, for example, along Duquesne Way and the Monongahela Wharf, would have to be completely filled in at once, and this latter work is included in the estimates.

The wall as located along the natural bank line has been taken up under the following headings:

1. With no Reservoirs or Dredging.
2. With Dredging only.
3. With Reservoirs only.
4. With Reservoirs and Dredging.

1. *Wall with no Reservoirs or Dredging.*

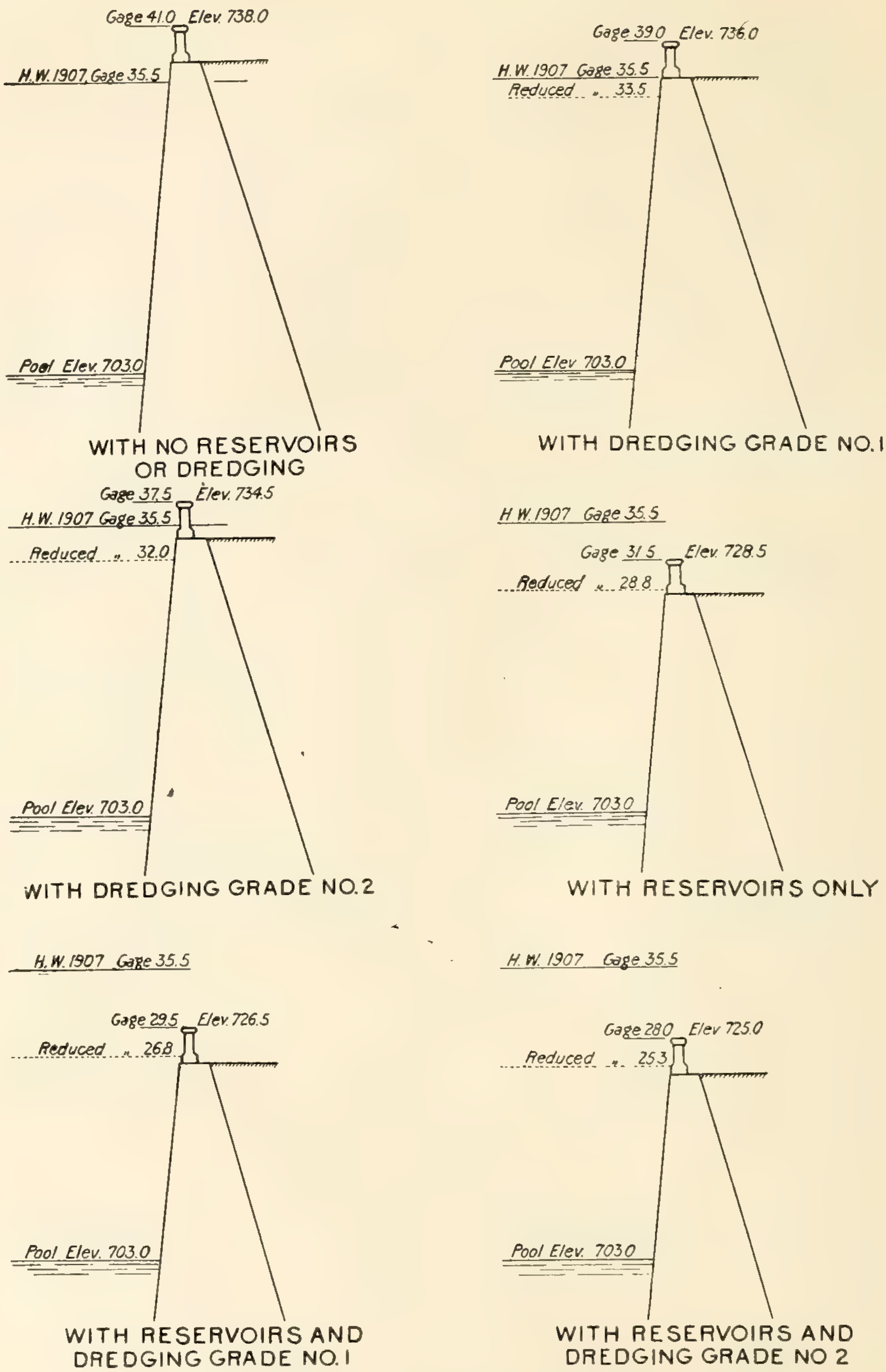
In this study the top of the wall proper has been placed 2 feet above the profile of the 1907 flood, that is, to gage height 37.5 feet at the Point. Adding 3.5 feet to this as the parapet height brings the top of the protection wall to gage height 41.0 feet, or elevation 738. Within the limits of the Flood Commission's city surveys, as shown on the "Map showing Extent of Surveys in Pittsburgh District," which accompanies this report, 55,110 feet of this wall will be required on the Allegheny, 46,930 feet on the Monongahela and 31,900 feet on the Ohio; a total of 133,940 feet, or about 25.4 miles. The height of this wall would vary from 10 to 47 feet, the average being 30 feet, which it is estimated would cost $100 per running foot. It is estimated that about 3,664,500 square feet of sheet piling would be required. To prevent backwater overflow in the various small creeks entering the rivers in the vicinity, about 66,960 feet of wall would have to be built, with an average height of 10 feet, and a cost per running foot of $20, or a total cost of about $1,339,000. This does not include the cost of the sheet piling that would be necessary in some sections of these creek walls to prevent seepage, which would bring the cost up to about $1,500,000.

The cost of this wall would therefore be subdivided and totaled as follows:

River wall, 133,940 ft. @ $100	$13,394,000
Sheet piling, 3,664,500 sq. ft. @ $1.00	3,664,500
Backfill, 60,000 cu. yds. @ $0.25	15,000
Walls up creeks	1,500,000
Total	$18,573,500

2. *Wall with Dredging only.*

Dredging to Grade No. 1.—The top of the parapet of this wall at the Point has been placed at gage height 39.0 feet, or elevation 736. As already shown, dredging to Grade No. 1 would effect a reduction in maximum flood height of about 2 feet at the Point, and a study of the profile as reduced by this dredging shows that it would reduce the average height of the wall from 30 feet to 29 feet, which would cost $95 per



FLOOD COMMISSION, PITTSBURGH, PA

CROSS SECTIONS OF RIVER WALL AT POINT

Showing

RELATION TO ACTUAL AND REDUCED CRESTS

FLOOD OF MARCH 15, 1907

running foot. The other items would be practically the same and the cost of this wall would sum up as follows:—

River wall, 133,940 ft. @ $95	$12,724,300
Sheet piling, 3,664,500 sq. ft. @ $1.00	3,664,500
Backfill, 60,000 cu. yds. @ $0.25	15,000
Walls up creeks	1,500,000
Total	$17,903,800

Dredging to Grade No. 2.—The top of the parapet of this wall at the Point has been placed at gage height 37.5 feet, or elevation 734.5. As already shown, dredging to Grade No. 2 would effect a reduction in maximum flood height of about 3.5 feet at the Point, and a study of the profile of the maximum flood surface as lowered by this dredging shows that it would reduce the average height of the wall from 30 feet to 28 feet, which would cost $90 per running foot. The other items would be unchanged and the cost of this wall would be divided and would total as follows:—

River wall, 133,940 ft. @ $90	$12,054,600
Sheet piling, 3,664,500 sq. ft. @ $1.00	3,664,500
Backfill, 60,000 cu. yds. @ $0.25	15,000
Walls up creeks	1,500,000
Total	$17,234,100

3. *Wall with Reservoirs only.*

This estimate is based upon a wall to gage height 28.0 feet at the Point, with the 3.5-foot parapet bringing the top of the flood barrier to gage height 31.5 feet, or elevation 728.5. The top of the wall parallels the profile of the 1907 flood as lowered by storage with the Seventeen Selected Projects. It is considered that this wall, in combination with the reduction in flood heights that could be obtained by reservoir storage, would prevent overflow by a forty-foot flood at Pittsburgh.

With this reduction by storage, no wall would be required on the Monongahela or Ohio Rivers; but it would be necessary to construct 23,830 feet, or about 4.5 miles of wall along the Allegheny. The height of this wall would vary from 9 to 30 feet, the average height being 14 feet, which would cost $28 a running foot. No sheet piling is included in this estimate, for with reservoir control, only the occasional great floods would reach a high enough stage to cause seepage. The amount of fill immediately necessary and the walls up the creeks have also been left out, as these items will practically disappear. The only item, therefore, would be the cost of the river wall, 23,830 running feet of which, at $28, would amount to about $667,200.

4. *Wall with Reservoirs and Dredging.*

Dredging to Grade No. 1.—This wall would be the same as under No. 3, except that the top of the wall proper at the Point would be at gage height 26.0 feet instead of 28.0 feet and its average height would be 12 feet instead of 14 feet, an average reduction of about 2 feet being effected by the dredging. At $22 per running foot, 23,830 feet of this wall would cost about $524,300.

Dredging to Grade No. 2.—This wall would be the same as with dredging to Grade No. 1 except that the top of the wall proper at the Point would be at gage height 24.5 feet instead of 26.0 feet, and its average height would be 11 feet instead of 12 feet, an additional average reduction of about one foot being effected by the deeper dredging. At $20 per running foot, 23,830 feet of this wall would cost $476,600.

WALL ALONG STANDARD CROSS-SECTION.

Insofar as existing conditions permit, the aim in this treatment of the problem has been to give the channels a uniform carrying capacity throughout the regulated por-

tion, by the adoption of a standard width and cross-section for each of the three rivers, and by widening or narrowing the channel to this adopted width, at the same time dredging it, when necessary, to the adopted cross-section. At bends in the river channels, where the distance between banks exceeds the adopted standard width, the position of the wall on each side has been selected with a view to flattening the curves as much as possible, by placing the wall along the outside of the bend out from the bank an amount equal to the excess channel width, and keeping the opposite wall along the natural bank line.

It is unfortunate that developments along the river banks prevent ideal treatment, and necessitate the adoption of a less width of standard cross-section on the Allegheny than on the Monongahela, the smaller of the two rivers. The width of this standard cross-section has been adopted as 850 feet on the Allegheny, 900 feet on the Monongahela and 1180 feet on the Ohio. There are points on each river where the width is less than this, but local conditions prevent widening to the adopted width. At these points the widest channel possible under the conditions has been obtained.

For example, on the Allegheny at 14th St., the width between banks at pool level is 760 feet, or 90 feet less than the adopted standard width. It was not thought wise to attempt to widen the channel at this point. Again, at 49th St., extensive fills along the left bank, now occupied by industrial plants, have narrowed the channel to 700 feet between banks, or 150 feet less than the adopted width. This has been increased to 770 feet, or 80 feet less than the adopted width, involving certain changes in the works bordering the left bank.

On the Monongahela, the width at a point 400 feet above the South Tenth St. bridge is only 750 feet between banks, or 150 feet less than the adopted standard width. It has not been possible to widen the channel at this point on account of the railroads on each bank.

On the Ohio, the channel narrows to about 1010 feet a mile below the Point. This has been increased to 1030 feet.

This wall location involves certain radical changes in river bank alignment, reclaiming very considerable areas of valuable land and largely increasing the efficiency and permanency of the channel.

On the Allegheny, the principal changes are at Herr Island and at Six Mile Island. At these points the wall line approximately follows the left bank, while the opposite wall parallels the left wall, giving a uniform width of 850 feet. This eliminates the back channels at these islands and increases the value of the island land by joining it to the mainland. The relocation of certain buildings and railroad tracks on Herr Island is involved. From the head of the island upstream along the right bank, a considerable strip of valuable land is reclaimed. Although the general width of the Allegheny below Dam No. 1 exceeds 850 feet, no contraction of the normal channel has been made, as it is considered that this additional width should be reserved for harbor purposes.

On the Monongahela, for the same reason, no reduction in channel width has been made below Dam No. 1. The principal change on this river is at the long bend in the vicinity of the Glenwood and B. & O. R. R. bridges, about six miles above the Point, where the wide channel has been narrowed to 900 feet, the adopted standard width, and a considerable strip of valuable land reclaimed along the left bank.

On the Ohio, the wall follows the right bank in general, except where it cuts across two long indentations in the bank line, one at the head and the other at the foot of Brunot Island. The left bank wall, however, leaves the shore at a point about 1500

feet above the head of Brunot Island, and paralleling the right bank wall at a distance of 1180 feet, the adopted standard width, cuts a strip from the main channel side of Brunot Island. This contemplates the filling in of the Brunot Island back channel, except a small channel to carry Chartiers Creek to the river.

It is considered that the conditions at Brunot Island offer a very considerable barrier to the free passage of floods down the Ohio. The straightaway course for the flow, especially during high flood velocities, is down the back channel, which is like a funnel, wide throughout its upper section, and contracting to a narrow exit at the foot of the island. The result is that, during floods, the water backs up in this channel, and the level of the water surface near the exit is sometimes as much as two feet above the water surface in the main channel. As stated in the discussion of dredging, the location of a wall along the natural bank line without reservoir control contemplates enlarging this exit from the present width of 520 feet to 630 feet, by cutting out the left bank of the McKees Rocks quarry. This, of course, is unnecessary with the location of a wall along the standard cross-section, as only the flow of Chartiers Creek must be accommodated. The Glass House Bar in the main channel opposite the upper part of Brunot Island also reduces the carrying capacity of the channel in this section. It is considered that no local treatment of the channel involving dredging would be successful at this point with the present channel alignment and division, as it is thought that the bar would rapidly form again after removal; whereas, with the regulation and straightening of the channel involved in this location of a wall along the standard cross-section, the channel, once dredged, would probably require little or no further attention.

The wall in general has been carried to pool level and the necessary amount below for suitable footings. The dredging is carried down to pool level at the wall, and from here drops off with a 3 to 1 slope to grade in the channel. At some points, as already described, the dredging is carried down to 10 feet below the pool level at the face of the wall, and from here slopes away from the wall on a 3 to 1 slope down to dredging grade. Along the paved banks of the B. & O. and P. & L. E. railroads, however, the wall has been placed at the top of the bank, raising the protection the necessary amount, and the dredging is planned so as not to interfere with the present bank protection. It is not considered wise to attempt to narrow the channel at wide points unless this work is supplemented by dredging to obtain a uniform carrying capacity throughout, as otherwise the channel would be restricted and the flood surfaces raised. On this wall location, therefore, no estimate has been made which does not include dredging, and there are accordingly but two headings under this study:

1. Wall with Dredging only.
2. Wall with Reservoirs and Dredging.

1. *Wall with Dredging only.*

Dredging to Grade No. 1.—The top of the parapet of this wall at the Point has been placed at gage height 39.0 feet, or elevation 736. As already shown, dredging to Grade No. 1 would effect a reduction in maximum flood height of approximately 2 feet at the Point. Within the limits included in the study, 166,620 feet, or about 31.5 miles of this wall would be required, the height varying from 9 to 51 feet, and averaging 34 feet, which would cost $125 per running foot. The same amount of backfill and of walls up creeks has been estimated for as with the location along the natural bank

line without reservoir control. The cost of this wall would be distributed and would total as follows:

River wall, 166,620 ft. @ $125	$20,827,500
Sheet piling, 3,604,000 sq. ft. @ $1.00	3,604,000
Backfill, 60,000 cu. yds. @ $0.25	15,000
Walls up creeks	1,500,000
Total	$25,946,500

Dredging to Grade No. 2.—Dredging to this deeper grade line would effect a reduction of approximately 3.5 feet at the Point. The top of the parapet of this wall at the Point has therefore been placed at gage height 37.5 feet, or elevation 734.5. 166,620 feet of this wall would be required, the height varying from 9 to 50 feet, and averaging 33 feet, which would cost $120 per running foot. The cost of this wall would be distributed and would total as follows:

River wall, 166,620 ft. @ $120	$19,994,400
Sheet piling, 3,604,000 sq. ft. @ $1.00	3,604,000
Backfill, 60,000 cu. yds. @ $0.25	15,000
Walls up creeks	1,500,000
Total	$25,113,400

2. *Wall with Reservoirs and Dredging.*

Dredging to Grade No. 1. This estimate, as with the similar wall in the location along the natural bank line, is based upon a wall to gage height 26.0 feet at the Point, with the parapet wall bringing the flood barrier up to gage height 29.5 feet, or elevation 726.5. The top of the wall parallels the profile of the 1907 flood as reduced by dredging combined with the storage of the Seventeen Selected Projects. This scheme would require 75,320 feet of wall on the Allegheny, 26,700 feet on the Monongahela and 22,850 feet on the Ohio; a total of 124,870 feet, or about 23.6 miles. No sheet piling or creek walls, and no backfill except that included in wall cost per running foot, are included in this estimate. The height of the wall would vary from 22 to 44 feet, the average height being 29 feet, 124,870 feet of which, at a cost of $95 per running foot, would amount to about $11,862,700.

Dredging to Grade No. 2. This wall would be the same as with the dredging to Grade No. 1, except that the top of the wall at the Point would be at gage height 24.5 feet instead of 26.0 feet, and its average height would be 28 instead of 29 feet. At $88 per running foot, 124,870 feet of this wall would amount to about $10,988,600.

The "Map showing Extent of Surveys in Pittsburgh District," accompanying this report, shows the location and extent of the wall along natural bank line, with and without reservoir control, together with the channel revisions at the three islands. The other wall location, along the standard cross-section, has not been placed on this map, for the reason that the studies and estimates, as shown later, proved this wall location to be unfeasible because of the greater cost. It was found, also, that the small scale of the map did not admit of showing both walls without crowding and obscuring the location of the adopted wall line.

SUMMARY OF COST OF RIVER WALLS.

Table No. 38 assembles the foregoing estimates, the totals enabling ready comparison of the cost of the various schemes.

LAND RECLAIMED BY WALL.

As previously stated in the discussion of wall location, there would be very considerable areas reclaimed through the construction of a river wall, especially in the case of the wall along the standard cross-section. A detailed estimate of the

TABLE No. 38.
COST OF VARIOUS WALL SCHEMES.

Scheme	Wall along natural bank line with						Wall along standard cross-section with			
	No reservoirs or dredging	Dredging only to		Reservoirs only	Reservoirs and dredging to		Dredging only to		Reservoirs and dredging to	
		Grade No. 1	Grade No. 2		Grade No. 1	Grade No. 2	Grade No. 1	Grade No. 2	Grade No. 1	Grade No. 2
River wall	$13,394,000	$12,724,300	$12,054,600	$667,200	$524,300	$476,600	$20,827,500	$19,994,400	$11,862,700	$10,988,600
Sheet piling	3,664,500	3,664,500	3,664,500	....	....	....	3,604,000	3,604,000	....	....
*Backfill	15,000	15,000	15,000	....	....	....	15,000	15,000	....	....
Walls up creeks	1,500,000	1,500,000	1,500,000	....	....	....	1,500,000	1,500,000	....	....
Total	$18,573,500	$17,903,800	$17,234,100	$667,200	$524,300	$476,600	$25,946,500	$25,113,400	$11,862,700	$10,988,600

*Considered immediately necessary in addition to amount used in estimating cost of wall per running foot.

TABLE No. 39.
TOTAL NET COST OF EACH SCHEME OF FLOOD RELIEF.

Scheme	Wall along natural bank line with						Wall along standard cross-section with			
	No reservoirs or dredging	Dredging only to		Reservoirs only	Reservoirs and dredging to		Dredging only to		Reservoirs and dredging to	
		Grade No. 1	Grade No. 2		Grade No. 1	Grade No. 2	Grade No. 1	Grade No. 2	Grade No. 1	Grade No. 2
Wall (Table No. 38)	$18,573,500	$17,903,800	$17,234,100	$667,200	$524,300	$476,600	$25,946,500	$25,113,400	$11,862,700	$10,988,600
Dredging	*95,000	852,700	3,054,900	....	852,700	3,054,900	2,760,600	5,612,400	2,760,600	5,612,400
Building and railroad relocation, Herr Island	....	....	....	....	....	....	800,000	800,000	800,000	800,000
Reservoirs	....	....	....	21,672,100	21,672,100	21,672,100	....	....	21,672,100	21,672,100
Total	$18,668,500	$18,756,500	$20,289,000	$22,339,300	$23,049,100	$25,203,600	$29,507,100	$31,525,800	$37,095,400	$39,073,100
Reclaimed land	2,788,600	2,788,600	2,788,600	584,000	584,000	584,000	11,204,000	11,204,000	10,341,500	10,341,500
Net total	$15,879,900	$15,967,900	$17,500,400	$21,755,300	$22,465,100	$24,619,600	$18,303,100	$20,321,800	$26,753,900	$28,731,600

*Enlarging mouth Brunot Island back channel.

value of this made land was obtained independently from several expert authorities, and the average prices adopted. It would seem that the value of the land created by the wall should be credited to it and deducted from the estimated cost to give the net cost of construction. The areas and values of this land for the various schemes are as follows:

WALL ALONG NATURAL BANK LINE.

1. *Wall with no Reservoirs or Dredging.*—This wall reclaims 52.2 acres of water-front land, 27.8 acres of which are along the Allegheny, 12.0 acres along the Monongahela, and 12.4 acres along the Ohio. The value of this land varies from $12,000 to $76,000 per acre, a small portion running as high as $10 per square foot, and the total value amounts to about $2,788,600.

2. *Wall with Dredging only.*—This wall reclaims the same land as the wall with no reservoirs or dredging.

3. *Wall with Reservoirs only.*—This wall is needed on the Allegheny only, where it reclaims 7.3 acres, the total value of which amounts to about $584,000.

4. *Wall with Reservoirs and Dredging.*—This wall reclaims the same land as the wall with reservoirs only.

WALL ALONG STANDARD CROSS-SECTION.

1. *Wall with Dredging only.*—This wall, as mentioned in the description of its location, reclaims large areas of waterfront land, at the same time increasing the value of the island land at Herr and Brunot Islands by joining it to the mainland. A certain amount of land bordering the rivers is cut off at some points, notably at the islands above mentioned, and the area of this land has been deducted from that of the reclaimed land to give the net area. The net area reclaimed is 179.4 acres along the Allegheny, 34.9 acres along the Monongahela, and 122.7 acres along the Ohio; a total of 337 acres. The value of this land, allowing for the areas cut off, amounts to $9,464,000. In addition to this amount, at Brunot Island, 106 acres of island land are joined to the mainland with a consequent increase in value of $10,000 per acre, or a total increase of $1,060,000; and at Herr Island, 34 acres of island land are made part of the mainland, increasing in value $20,000 per acre, or a total increase of $680,000. This brings the total amount to be credited to this wall for creation and increase of land values to about $11,204,000.

2. *Wall with Reservoirs and Dredging.*—This wall also reclaims large areas and makes the same additions in value at the islands as the wall with dredging only. The net area reclaimed is 179.4 acres along the Allegheny, 31.7 acres along the Monongahela and 112.6 acres along the Ohio; a total of 323.7 acres. The value of this land, allowing for the areas cut off, amounts to $8,601,500. Adding $1,060,000 for the increase in land value at Brunot Island and $680,000 for that at Herr Island brings the total amount to be credited to this wall for creation and increase of land values to about $10,341,500.

NET COST OF EACH WALL SCHEME.

To enable comparison of the various wall schemes, it is necessary to sum up the total cost of the respective methods of flood relief of which they form a part. Table No. 39 on page 211 gives these data in condensed form.

A brief study of the above table determines certain facts, namely:

1. The decrease in wall cost effected by dredging does not warrant the expense of such work.

2. The net cost of the wall located along the standard cross-section is so much greater than that of the wall following the natural bank line that adoption of the former is prohibited.

3. The final comparison and selection reduces itself to two schemes, wall along natural bank line without reservoirs, and wall along natural bank line with reservoirs.

4. Of these two schemes, the method of relief by wall alone is the cheaper by $5,875,400.

Although, as stated above, dredging cannot be recommended because of its cost, it is considered that a certain improvement in the carrying capacity of the channels could be obtained by properly directing the work of private sand and gravel dredges, operating under permits of the Secretary of War, and planning the dredging carried on by the government dredges. An inspection of the bed of the rivers, as shown on the city maps accompanying this report, will show the extreme irregularity of the river bottom, much of which is due to the random operations of sand and gravel dredges. Instead of scooping out huge holes by remaining on one spot, these diggers could change position at short intervals and cut off the bottom to an even grade. This work, if properly directed, combined with the dredging now carried on from time to time by the government dredges, would tend toward, and in time to some extent produce the effect shown for at least the upper of the two dredging grades, No. 1.

COMBINATION OF THE TWO WALL LOCATIONS.

Although, as a whole, the wall located along the standard cross-section is not feasible on account of its greater cost, it is possible to combine certain channel revisions which it contemplates with the cheaper location along the natural bank line, and to secure thereby a lower net cost than that of either of the projected locations above studied, at the same time including the principal channel improvements of the more expensive wall. There are three points where this improvement of the channel and saving in cost can be effected, at Brunot Island, on the Ohio, and at Herr and Six Mile Islands on the Allegheny.

BRUNOT ISLAND.

As previously stated, the location contemplated with the wall along the standard cross-section considerably improves the efficiency and permanency of the channel at this point. The combination of the two wall locations uses the location along the natural bank line on the right shore, but from the point where the two locations diverge, 1500 feet above the head of Brunot Island, adopts the other location for the left wall, and uses this line for the left bank to the foot of the island. This eliminates the back channel and enables the land reclamation already described. The corresponding location on the right bank was not adopted, as estimate showed that the value of the reclaimed land did not offset the greater cost. The value of the land reclaimed on the left bank with this combination, however, is very considerable, and exceeds the actual cost of all the work. 137 acres of new land are made, and 106 acres of present island land are joined to the mainland, the other 51 acres being cut off by dredging outside the wall line. The island land as it now stands is worth about $2,000 an acre, while joined to the mainland, its value would be in the neighborhood of $12,000 an acre. The value of this land would therefore be as follows:

137 acres reclaimed land @ $12,000	$1,644,000
106 acres joined to mainland @ $10,000	1,060,000
	$2,704,000
Deduct 51 acres cut off @ $2,000	102,000
Net value reclaimed land	$2,602,000

Throughout this stretch this combination includes the dredging to Grade No. 1 contemplated with the location along the standard cross-section. In the case of the wall without reservoir control, it will be necessary to build the walls up Chartiers Creek, as well as the wall along the left bank of the Brunot Island back channel from the mouth of the creek to the mouth of the back channel. As the walls up the creek are common to both schemes, they are omitted in this comparative estimate.

The cost of the two schemes with and without reservoir control, considering here only the stretch involved in the change, as described above, would be as follows:

Wall without Reservoir Control.

1. *Following original location along natural bank line.*

River wall, 10,440 feet @ $55	$ 574,200
Enlarging mouth back channel	95,000
	$ 669,200
Value reclaimed land	62,600
Net cost project	$ 606,600

2. *Revised as described above.*

River wall, 8,680 feet @ $125	$1,085,000
River wall, 3,020 feet @ $ 80	241,600
Dredging, 3,164,400 cubic yards @ $0.25	791,100
	2,117,700
Value reclaimed land	2,602,000
Land value exceeds cost project	484,300
Cost with other location (see above)	606,600
Saving by combination of locations	$1,090,900

Wall with Reservoir Control.

1. *Following original location along natural bank line.*
(No wall is needed on the Ohio with reservoir control.)

2. *Revised as described above.*

River wall, 2,670 feet @ $95	$ 253,600
River wall, 6,020 feet @ $60	361,200
Dredging, 3,164,400 cubic yards @ $0.25	791,100
	1,405,900
Value reclaimed land	2,602,000
Saving by combination of locations	$1,196,100

HERR ISLAND.

In this combination of the two wall locations, the location along the natural bank line is used on the left shore, while the right bank wall takes the other location from the

mouth of Pine Creek, 3100 feet above the head of the island, to the point where the two wall lines join, about 1900 feet below the foot of the island, thus eliminating the back channel, and substituting a single channel 850 feet wide, dredged to Grade No. 1.

The value of the land reclaimed on the right bank with this location is very considerable and nearly equals the cost of all the work. 38.9 acres are reclaimed, and 34 acres of island land are joined to the mainland, the other 9.9 acres of the island being cut off by the dredging outside the wall. The island land as it now stands is worth about $20,000 an acre, while joined to the mainland its value would be about $40,000 an acre. The net value of the reclaimed land would be as follows:

38.9 acres reclaimed land @ $40.000	$1,556,000
34.0 acres joined to mainland @ $20,000	680,000
	2,236,000
Deduct 9.9 acres cut off @ $20,000	198,000
Net value reclaimed land	$2,038,000

This combination includes the dredging to Grade No. 1 contemplated with the location along standard cross-section. The cost of the two schemes, with and without reservoir control, considering here only the stretch between the points where the two locations diverge, as described above, would therefore be as follows:

Wall without Reservoir Control.

1. *Following original location along natural bank line. (No land reclaimed.)*	
River wall, 7,930 feet @ $70	$ 555,100
2. *Revised as described above.*	
River wall, 9,140 feet @ $150	1,371,000
Dredging, 1,233,600 cubic yards @ $0.25	308,400
Buildings and railroad relocation	800,000
	2,479,400
Value reclaimed land	2,038,000
Net cost project	441,400
Cost with other location (see above)	555,100
Saving by combination of locations	$ 113,700

Wall with Reservoir Control.

1. *Following original location along natural bank line. (No land reclaimed.)*	
River wall, 2,760 feet @ $25	$ 69,000
2. *Revised as described above.*	
River wall, 9,140 feet @ $95	868,300
Dredging 1,233,600 cubic yards @ $0.25	308,400
Buildings and railroad relocation	800,000
	1,976,700
Value reclaimed land	2,038,000
Land value exceeds wall cost	61,300
Cost with other location (see above)	69,000
Saving by combination of locations	$ 130,300

SIX MILE ISLAND.

This combination of the two wall locations adopts the natural bank line location along the left bank. The right wall, however, is placed on the other alignment from Dam No. 2 to a point 3100 feet below the foot of Six Mile Island, where it joins the natural bank line location and follows this alignment to Pine Creek, where the Herr Island scheme begins. Starting at the right abutment of Dam No. 2, this right bank wall swings out into the channel with a smooth, gradual curve, and reduces the width to about 900 feet at a point 500 feet above the Highland Park bridge. From here it parallels the left bank at this 900-foot width to the foot of the island, and then gradually swings over to join the natural bank line wall 3100 feet below the foot of the island. The channel is dredged to Grade No. 1 throughout this section. This location reclaims 60 acres of land, which is worth about $21,000 an acre in this locality.

The cost of the two schemes, with and without reservoir control, considering here only the part involved within the above described limits, is as follows:

Wall without Reservoir Control.

1. *Following original location along natural bank line.*

River wall, 4,490 feet @ $105	$ 471,450
River wall, 1,390 feet @ $125	173,750
	645,200
Reclaimed land, 9 acres @ $21,000	189,000
Net cost project	$ 456,200

2. *Revised as described above.*

River wall, 5,050 feet @ $140	$ 707,000
River wall, 2,780 feet @ $125	347,500
Dredging, 1,134,000 cubic yards @ $0.25	283,500
	1,338,000
Reclaimed land, 60.4 acres @ $21,000	1,268,400
Net cost project	$ 69,600
Cost with other location (see above)	456,200
Saving by combination of locations	386,600

Wall with Reservoir Control.

1. *Following original location along natural bank line.*

River wall, 4,090 feet @ $55	$ 224,950
Reclaimed land, 4.1 acres @ $21,000	86,100
Net cost project	$ 138,850

2. *Revised as described above.*

River wall, 5,050 feet @ $95	$ 479,750
River wall, 2,780 feet @ $90	250,200
Dredging, 1,134,000 cubic yards @ $0.25	283,500
	1,013,450
Reclaimed land, 60.4 acres @ $21,000	1,268,400
Land value exceeds wall cost	254,950
Cost with other location (see above)	138,850
Saving by combination of locations	$ 393,800

FINAL SUMMARY OF COST OF FLOOD RELIEF.

It has been shown in the preceding pages that the economical wall to build is the one located along the natural bank line without dredging; and that the net cost of the wall thus located can be decreased and the channel greatly improved by making the above-described revisions at the three islands. The net cost of the two revised schemes, wall without reservoirs or dredging, and wall with reservoirs only, therefore reduces to the following:

Wall without Reservoirs or Dredging.

Net cost of project (Table No. 39)		$15,879,900
Saving, Brunot Island revision	$1,090,900	
Saving, Herr Island revision	113,700	
Saving, Six Mile Island revision	386,600	
Saving, total		1,591,200
Net cost of project with island revisions		$14,288,700

Wall with Reservoirs Only.

Net cost of project (Table No. 39)		$21,755,300
Saving, Brunot Island revision	$1,196,100	
Saving, Herr Island revision	130,300	
Saving, Six Mile Island revision	393,800	
Saving, total		1,720,200
Net cost of project with island revisions		$20,035,100
Difference between net costs with island revisions		5,746,400

DISCUSSION.

If the objections to such a high wall were not so serious; if the fact that flood relief for Pittsburgh by a protection wall only would afford no flood relief except to Pittsburgh, leaving other river communities above and below to work out their own salvation, were ignored; if the headroom under low bridges, and the conditions affecting loading and unloading of river craft and governing future sewerage plans were not so notably improved by the reduction of flood heights; and if the increase of the low-water flow that would be obtained by means of the storage reservoirs were not of such *tremendous importance and benefit* to navigation, sanitation, water supply and water power, the lower cost of the wall without reservoir control would recommend the adoption of that means of flood relief.

A wall of limited height along the river front is desirable for many reasons. It would reclaim considerable areas of valuable land, and would greatly improve the appearance and usefulness of the river banks. If properly located and constructed it would also facilitate the handling of cargoes to and from the river boats. For these reasons, the low wall necessary for flood control in combination with the proposed storage reservoirs could be extended advantageously beyond the low-lying parts of the river bank, where it would be needed for flood protection.

There are serious objections, however, to the wall that would be necessary without reservoir control, on account of its height above the present surface at many points. Along Duquesne Way, for example, the top of the parapet would be about 13 feet above street level, while on the opposite bank of the Allegheny it would be about 19 feet above the Baltimore and Ohio tracks. Building, bridge and railroad grades would prevent raising the ground behind the wall by this amount and the city at these points would resemble an old walled town of medieval times. The top of the wall, moreover,

would be 35 feet above pool level in Pittsburgh Harbor and it would be an expensive and difficult matter to provide convenient approaches to the river front slopes as now used for loading and unloading purposes. If the channel were dredged and the barges and steamers brought alongside the wall, this difficulty would be eliminated; but it would still be less convenient than the lower wall, because the great variations in water stage would still continue and these greater fluctuations of water levels would mean greater vertical distances to raise and lower cargoes.

With such a high wall and no reduction of the flood heights, the sewerage problem of the city would also be more difficult and expensive of solution. Whatever may be the details of the final plan that will be worked out for the disposal of the sewage of the Pittsburgh District, the general scheme will probably include the construction of an intercepting sewer along the waterfront. At times of flood, the sewage must be raised from this sewer with suitable pumping apparatus to above high-water level. The reduction in flood heights that would be obtained by storage reservoirs would considerably reduce the amount and lift of this pumping, and greatly simplify the construction and lessen the cost of the interceptor and pumping apparatus.

But even if these difficulties should be surmounted, a broad view of the whole problem does not admit of the adoption of a method of flood relief by protection alone, for, as already stated, the flood relief obtained would be local only, and the communities along the rivers above and below Pittsburgh would continue to have their floods as before. Moreover, flood relief would be the only benefit obtained, for there would be no increase in the low-water flow of the rivers and their tributaries, and hence no benefits to navigation and water power, no improvement in the quality of the water for domestic and industrial supply, and no dilution of the sewage of cities and towns along the rivers, an important sanitary feature.

In the following chapters, the effect of the proposed storage reservoirs upon the high-water and low-water flow of the streams is shown, together with the benefits that would result from such improvement in stream regimen.

CHAPTER IX.

EFFECT OF STORAGE RESERVOIRS ON FLOW OF RIVERS ABOVE AND BELOW PITTSBURGH.

Introduction—Effect on High Water —Ohio—Allegheny—Kiskiminetas—Monongahela—West Fork—Youghiogheny—Effect on Low Water—Allegheny — Kiskiminetas — Monongahela—West Fork—Tygart Valley—Youghiogheny—Ohio.

INTRODUCTION.

Any solution of the Pittsburgh Flood Problem including the construction of storage reservoirs for flood control obviously greatly extends the scope of the studies. If the remedy confines itself to some local means of relief, as walls or dredging, the benefits will in like manner be local, and, moreover, confined to flood relief only. With flood control by reservoir storage, however, the investigation, after dealing with the effect of such storage upon high water at Pittsburgh, naturally turns to a consideration of the reduction of flood heights on the Ohio below Pittsburgh, and on its tributaries above that point. The benefits that would result from an extension of flood prevention along the river valleys above and below Pittsburgh would obviously be of tremendous importance to the communities bordering these rivers.

It also becomes necessary to investigate the increase in low-water stages that could be obtained upon the main rivers and their tributaries by the release during dry weather of the impounded flood water, or of such part of it as could safely be retained in the reservoirs until this time. A determination of this increase in dry-weather flow by storage reservoirs enables a study of their relation to navigation, sanitation, water supply and water power, which will be taken up in subsequent chapters.

EFFECT ON HIGH WATER.

REDUCTION OF FLOOD HEIGHTS ON OHIO RIVER BELOW PITTSBURGH.

The first considerable tributary of the Ohio below Pittsburgh is the Beaver River, which drains 3040 square miles, and enters from the north, about 25 miles below Pittsburgh. The reduction of floods throughout these 25 miles would be practically the same as at Pittsburgh.

At Wheeling, W. Va., 90 miles below Pittsburgh, the Ohio drains 23,800 square miles, or 4880 square miles more than at Pittsburgh. It is possible that certain flood rainfalls may have great intensity over this portion of the Ohio Basin below Pittsburgh, and on this account it is evident that in such cases the percentage of reduction in discharge at Wheeling would probably be less than at Pittsburgh, unless additional storage were constructed on tributaries entering the Ohio below Pittsburgh. But it is true that for every flood originating above Pittsburgh, as practically all the Wheeling floods do, there would be a reduction in the Wheeling discharge practically as great as the reduction at Pittsburgh.

The greatest recorded flood at Wheeling was in 1884, when a stage of 53.1 feet was reached, equivalent to a discharge of about 488,000 second-feet. This flood reached at Pittsburgh a gage height of 33.3 feet, exceeded only by the flood of March, 1907. This Pittsburgh stage would have been reduced well below the danger line, or 22-foot stage, by

the proposed reservoir control. Assuming it to have been lowered only to the 22-foot stage, there would have been a reduction in discharge at the time of flood peak of 155,000 second-feet. A reduction of this amount in the Wheeling flow would have brought the discharge down to 333,000 second-feet, corresponding to a gage height of 40.0 feet, making a reduction in flood height of 13.1 feet.

The flood of March, 1907, reached a stage of 50.1 feet at Wheeling. If the 43 projects had been in operation, this flood would have been lowered to 25.3 feet at Pittsburgh, a reduction in discharge of 169,000 second-feet. The discharge at Wheeling corresponding to gage height 50.1 feet is 452,390 second-feet. Reducing this by 169,000 second-feet gives 283,390 second-feet, corresponding to a gage height of 35.6 feet; making a reduction of 14.5 feet in the Wheeling flood, and lowering it to 0.4 foot below the danger mark of 36.0 feet.

Proceeding further down the Ohio, it is evident that, as other important tributaries enter, and the proportion of drainage independent of the part controlled by the reservoirs above Pittsburgh increases, this storage becomes a less factor in reducing Ohio floods. Insofar as they originate above Pittsburgh, the storage will be effective; but complete control of floods at these lower points will necessitate the construction of additional storage on tributaries entering the Ohio between Pittsburgh and the point where flood relief is desired.

REDUCTION OF FLOOD HEIGHTS ON TRIBUTARIES ABOVE PITTSBURGH.

If the 17 most effective projects were constructed, the reduction of the flood stage in the tributaries above Pittsburgh receiving the flow of the controlled streams would be as follows:—

Allegheny River.

The greatest flood in this river at Kittanning since 1865 was that of March, 1905, which was only about 6 inches below the earlier flood. The crest of the 1905 flood reached, at Kittanning, a gage height of 28.8 feet, corresponding to a discharge of 240,-250 second-feet. The proposed reservoir control above Kittanning would have reduced this gage height to 17.3 feet, or 99,550 second-feet discharge; a reduction in stage of 11.5 feet and in discharge of 140,700 second-feet.

The flood of February 16, 1908, which reached a stage of 24.8 feet at Kittanning, would have been reduced to a stage of 16.2 feet, a reduction of 8.6 feet. The flood of March, 1907, though the greatest on record at Pittsburgh, reached a stage of only 15.9 feet at Kittanning, as the rainfall in the upper Allegheny was very light. This flood has therefore not been considered in this connection.

The reductions in stage of the floods of 1905 and 1908 would be about the same amounts as at Kittanning as far up as Oil City, and from Kittanning to Pittsburgh, a total distance of about 134 miles. It is obvious what this would mean to present sufferers from floods along this river. At Kittanning, for example, overflow of the banks does not begin until the gage is well above 20 feet, whereas it would probably never exceed 18.0 feet with the proposed reservoir control.

Kiskiminetas River.

The 1907 flood was very high on this stream, as its basin received a heavy rainfall. The gaging station at Avonmore was not established until May, 1907, and no gage height of the 1907 flood crest is available at that point. By a study of the Saltsburg gage heights, however, it has been estimated that the probable maximum stage reached at Avonmore in March, 1907, was 33.8 feet, corresponding to a discharge

of 76,600 second-feet. With the proposed storage on Loyalhanna and Black Lick Creeks, this would have been lowered to 25.2 feet, corresponding to a discharge of 50,200 second-feet; a reduction of 8.6 feet in gage height and 26,400 second-feet in discharge. The flood of March 20, 1908, reached a gage height of 30.8 feet at Avonmore, which would have been reduced by the proposed storage to 20.8 feet, a reduction of 10 feet. The reduction would equal about these amounts from Saltsburg to the mouth, a distance of 26 miles.

Monongahela River.

The greatest flood on record in this river was on July 11, 1888, when the gage at Lock No. 4 recorded 42.0 feet, corresponding to a discharge of 207,000 second-feet. The 1907 flood reached at this point a height of 37.4 feet, corresponding to a discharge of 170,200 second-feet. The storage above this point contemplated with the 17 most effective projects, namely the Cheat and West Fork reservoirs, would have reduced the 1888 flood to 28.5 feet, or 103,000 second-feet discharge, and the 1907 flood to 32.8 feet, or 134,000 second-feet discharge.

West Fork Monongahela.

The greatest flood on record in this river was also in July, 1888. The gaging station at Enterprise, W. Va., was not established until 1907, but the high-water mark of 1888, referred to the gage, gives about 33.0 feet as the stage, corresponding to a discharge of about 40,000 second-feet, or 54 second-feet per square mile for the 744 square miles of drainage area. The storage at the West Fork reservoir, controlling a drainage area of 366 square miles, or about 50 per cent of that at Enterprise, would reduce this flow to about 20,400 second-feet, or 19 feet gage height. The highest stage reached since the establishment of the Enterprise gage was on May 4, 1908, when there was a discharge of 16,000 second-feet at gage height 16.4 feet. The West Fork reservoir would have reduced this stage by about 6 feet.

Youghiogheny River.

The maximum stage on record in this stream occurred on March 14, 1907, when a gage height of 28.2 feet was recorded at West Newton. The previous maximum was 22.0 feet, on January 22, 1904. With the exception of a few low-water measurements, no discharge measurements have been made at West Newton, and no rating table is available for this station. An estimate of the flow at a gage height of 28.2 feet, made by a study of the flow of the three branches above Confluence, where gaging stations have been in operation since 1904, places the discharge at West Newton at about 62,000 second-feet, or about 40 second-feet per square mile of tributary drainage area. The storage contemplated on the Youghiogheny above Confluence, Youghiogheny reservoir No. 2, would have reduced the West Newton stage by about 5 feet, the Connellsville stage a like amount and the Confluence stage a somewhat greater amount. The above reductions in flood heights on the Youghiogheny would of course be very considerably greater if all or part of the storage found available in addition to that selected were constructed.

The following table groups the above data in convenient form for inspection and reference.

TABLE No. 40.

REDUCTION OF FLOOD CRESTS BY SEVENTEEN SELECTED PROJECTS.

Stream	Date of flood	Station on stream	Gage height, (feet)			Discharge, (second-feet)			Drainage area		
			Actual	Reduced by storage	Amount of reduction	Actual	Reduced by storage	Amount of reduction	Above station	Controlled	
									Square miles	Square miles	Per cent of total
*Ohio	Feb. 7-84†	Wheeling	53.1	40.0	13.1	488000	333000	155000	23800	11833	45.0
*Ohio	Mar. 15-07	Wheeling	50.1	35.6	14.5	452390	283390	169000			
Allegheny	Mar. 20-05**	Kittanning	28.8	17.3	11.5	240250	99550	140700	9010	7045	78.0
Allegheny	Feb. 16-08	Kittanning	24.8	16.2	8.6	196620	89360	107260			
Kiskiminetas	Mar. 14-07‡	Avonmore	33.8	25.2	8.6	76600	50200	26400	1720	691	40.0
Kiskiminetas	Mar. 20-08	Avonmore	30.8	20.8	10.0	67255	38110	29145			
Monongahela	July 11-88†	Lock No. 4	42.0	28.5	13.5	207000	103000	104000	5430	1765	32.5
Monongahela	Mar. 14-07	Lock No. 4	37.4	32.8	4.6	170200	134000	36200			
West Fork	July 88†	Enterprise	33.0	19.0	14.0	40000	20400	19600	744	366	49.2
West Fork	May 4-08	Enterprise	16.4	10.4	6.0	16000	8130	7870			
Youghiogheny	Mar. 14-07†	W. Newton	28.2	23.2	5.0	62000	------	------	1550	394	25.4

* Assuming 43 projects constructed.
† This is maximum on record.
** Maximum in March, 1865, gage height, 29.3=245,200 sec.-ft.
‡ Maximum in 1859, gage height, 34.9=80000 sec.-ft.

EFFECT ON LOW WATER.

The amount of water that could safely be stored for use during dry weather must at this stage of the investigations be largely based on assumptions made with a considerable factor of safety. More complete data as to run-off, stream-flow and time of movement of flood waves of the various tributaries, all of which would be essential to intelligent and effective operation of the reservoir system, would later enable more definite estimates as to the proportion of the storage of the respective projects that could be reserved and utilized for the improvement of low-water conditions. And finally, the actual operation of the system of reservoirs would quickly demonstrate the modifications that would have to be made in the preliminary estimates.

With present knowledge, however, certain definite statements are quite self-evident. For example, a reservoir, even when full at the time of a flood, has a regulating effect upon the flow of the stream below. Before the flood can attain its full rate of discharge it must store enough water in the reservoir to raise the height of the water over the spillway the necessary amount to give that discharge. This action may be a danger or a benefit. If the time of arrival of the tributary flood wave from that point is before crest time of that particular flood at Pittsburgh, there is danger that the delay at the reservoir may bring the flood wave to Pittsburgh at the critical or peak time, and perhaps raise the flood stage considerably above what it would have been had there been no reservoir at the point in question. On the other hand, if under natural conditions the flood wave of that particular tributary arrived at Pittsburgh at or after flood peak time, with the reservoir constructed and filled at the beginning of the flood, the retardation of the arrival of its flood wave at Pittsburgh would lower the Pittsburgh flood. In short, it may be accepted as universally true, that if the time of arrival of the flood wave of a tributary is before the crest at Pittsburgh, it is dangerous to keep the reservoir on that tributary full; and, conversely, if the flood water of a tributary never arrives at Pittsburgh before and generally arrives after peak time, a large part of its capacity can safely be utilized for retaining the impounded water until needed.

It seems reasonable to assume that the equivalent of fifty per cent of the storage capacity of each of the projects can safely be retained until needed for low-water assistance. The following discussion, therefore, will show the effect of storage upon the low-

water discharge, with reservoirs half full. To this has been added, in order to show possibilities, a study of the low-water flow that might be obtained with reservoirs three-quarters full and entirely full. These studies are made both with the Seventeen Selected Projects and with all forty-three projects.

The conditions of extreme low-water flow that occurred during the summer and autumn of 1908 will be used for this purpose. This year, although not one of great deficiency in precipitation, was one of the lowest in stream-flow of any on record.

INCREASE IN LOW-WATER FLOW OF TRIBUTARIES ABOVE PITTSBURGH.

The improvement of the low-water discharge with various amounts of storage would be as follows:

Allegheny River at Kittanning.

All the Allegheny projects, except Black Lick, Loyalhanna, Crooked and Buffalo, lie above Kittanning. The discharge at this point, in 1908, was below 2,900 second-feet from August 14 to December 17, the average for the 126 days being 1,241 second-feet. For 48 days, scattered through September, October and November, the discharge was below 1,000 second-feet; while for 19 days during these months, it was only 850 second-feet, corresponding to a gage height of about 1.3 feet.

Ten of the Seventeen Selected Projects control drainage above Kittanning. With these reservoirs half full at the middle of August, a constant flow of 2,900 second-feet, or over three times the minimum, could have been maintained throughout the low-water season. This corresponds to a gage height of 2.7 feet, and therefore represents an increase of 1.4 feet in minimum stage. With the reservoirs three-quarters full, the discharge would not have fallen below 3,700 second-feet, or gage height 3.1 feet; while if the reservoirs had been full at the beginning of August, a constant flow of 4,500 second-feet, or over 5 times the minimum, would have been maintained, causing an increase of 2.1 feet in the minimum stage.

With all forty-three projects constructed to maximum capacity, the storage above Kittanning would have maintained the low-water flow and stage at the following amounts: reservoirs half full, 3,400 second-feet, 3.0 feet; reservoirs three-quarters full, 4,400 second-feet, 3.4 feet; reservoirs full, 5,350 second-feet, 3.8 feet. This uniform discharge that would be obtained with reservoirs full is over 6 times the minimum, and represents an increase in minimum stage of 2.5 feet.

Allegheny River at Freeport.

The Allegheny at Freeport would receive low-water assistance from all the projects in this basin, as they are all located above this point. During the 134 days from August 5 to December 16, 1908, the discharge at Freeport was below 3,400 second-feet for 124 days, the average discharge during this period being 1,454 second-feet. The discharge was below 1,000 second-feet for 19 days, and for 8 days in September was only about 950 second-feet, corresponding to a gage height of 0.2 foot.

The Seventeen Selected Projects include thirteen on the Allegheny Basin. With these reservoirs half full at the beginning of August, the flow could have been maintained at 3,400 second-feet, or over 3.5 times the minimum. This discharge corresponds to a gage height of about 2.0 feet, and therefore represents an increase of 1.8 feet in minimum stage. With the three Clarion reservoirs 65 per cent full, Tionesta and North Branch of French reservoirs 75 per cent full, and the remaining eight half full, the discharge could have been maintained at 3,700 second-feet, or gage height 2.2 feet, throughout the dry season. With all thirteen reservoirs three-quarters full, a constant flow of 4,350 second-feet, and stage of 2.4 feet, could have been obtained; while with the reservoirs entirely

full at the beginning of August, a uniform discharge of 5,350 second-feet could have been maintained, corresponding to a gage height of 2.8 feet, and hence representing an increase in minimum stage of 2.6 feet.

With all forty-three projects constructed to maximum capacity, the following discharges and stages could have been maintained constantly throughout that period of the year when the actual discharge and stage fell below the respective amounts: reservoirs half full, 3,850 second-feet, 2.2 feet; reservoirs three-quarters full, 5,000 second-feet, 2.6 feet; reservoirs full, 6,050 second-feet, 3.0 feet. This uniform discharge with reservoirs full is over 6 times the minimum discharge, and gives an increase of 2.8 feet in minimum stage.

Allegheny River at Pittsburgh.

The discharge of the Allegheny River at Pittsburgh was below 3,450 second-feet for 124 days between August 14 and December 17, 1908, during which period the average flow was 1,500 second-feet. For 8 consecutive days in September, the discharge was only about 1,000 second-feet. With the assistance of the thirteen Allegheny reservoirs included in the Seventeen Selected Projects, the following discharges could have been maintained throughout that period of the year when the actual discharge fell below the respective amounts; reservoirs half full, 3,450 second-feet, or about 3.5 times the minimum, 124 days; reservoirs three-quarters full, 4,400 second-feet, 132 days; reservoirs full, 5,400 second-feet, 143 days.

With all forty-three projects constructed to maximum capacity, those included in the Allegheny Basin would have maintained the following discharges at Pittsburgh throughout the dry season: half full, 3,900 second-feet, 128 days; three-quarters full, 5,100 second-feet, 140 days; full, 6,100 second-feet, 150 days.

On account of the influence of the navigation dams on gage heights, no corresponding increases of stage in Pittsburgh Harbor are given here; but this subject is fully discussed in the following chapter on the Relation of Storage Reservoirs to Navigation.

Kiskiminetas River.

There are only two reservoirs on the drainage area of this river, Loyalhanna and Black Lick, both of which are included in the Seventeen Selected Projects. The improvement of low-water flow may therefore be considered to extend from the mouth of Black Lick Creek to the mouth of the Kiskiminetas, a distance of 41 miles, and its amount from Saltsburg down is shown by a study of the discharge at Avonmore, 21.5 miles above the mouth.

During the 173 days from June 28 to December 18, 1908, the discharge at Avonmore was below 400 second-feet, or gage height 2.5 feet, for 137 days. The average discharge for these 137 days was 166 second-feet, and it fell below 100 second-feet for 39 days of this time, while for 10 days, in the latter part of September, it was only 65 second-feet, corresponding to a gage height of 1.6 feet. With reservoirs half full at the end of June, the minimum flow would not have fallen below 400 second-feet, or 6 times the actual minimum, during the entire period, for the impounded water would have been sufficient to supply an auxiliary flow of 234 second-feet for 137 days, with an excess of 14,000,000 cubic feet. This increased flow is equivalent to a gage height of 2.5 feet, and therefore represents an increase in minimum stage of 0.9 foot. It is not considered safe, with present knowledge, to figure on keeping these reservoirs more than half full, though fuller data and actual operation of the reservoirs might later show that this could be done.

Monongahela River at Pittsburgh.

On account of the navigation dams in the Monongahela, it has not been possible to obtain a record of the daily low-water flow. The Annual Report of the Water Supply Commission of Pennsylvania, for 1908, estimates, by subtracting the flow of the other tributaries from that of the Ohio River, that the minimum discharge of the Monongahela in 1908 was about 325 second-feet. The Annual Reports of the Chief of Engineers of the United States Army give the minimum discharge as 160 second-feet, which occurred in 1895, the dryest season on record.

As the daily flow is not available, estimates of the increased low-water discharge similar to those for the other streams cannot be presented; but the following figures, obtained in each case by adding the artificial flow to the natural minimum flow, will serve as an index of what may be expected, and are of course lower than would actually be obtained, as the average flow for the periods considered must have been greater than the minimum flow. In each case the same number of days has been considered as with the corresponding conditions on the Allegheny.

Four of the Seventeen Selected Projects are located in the Monongahela Basin. With these reservoirs half full at the beginning of the low-water season, an additional flow of 800 second-feet could have been maintained for 124 days, making, in 1908, a total discharge of 1,125 second-feet, or about 3.5 times the minimum. It is probable that a knowledge of actual conditions of flow during this period would have raised this estimated constant flow to about 1,300 second-feet, as the average flow of the Allegheny during this period was about 50 per cent. greater than the minimum and it may be assumed that approximately the same relation would obtain on the Monongahela. With reservoirs three-quarters full, 1,140 second-feet could be added to the flow for 132 days, while with reservoirs full, 1,400 second-feet would be available for low-water assistance for a period of 143 days.

In the same way, in 1895, the uniform low-water discharges for the above conditions would have been as follows: reservoirs half full, 960 second-feet, or 6 times the minimum of 160 second-feet; reservoirs three-quarters full, 1,300 second-feet; reservoirs full, 1,560 second-feet.

Twenty-two of the forty-three projects are located in the Monongahela Basin. With these reservoirs constructed to maximum capacity, and half full at the beginning of the summer, 2,170 second-feet could be added to the natural flow for 128 days, giving a total flow of about 2,500 second-feet, or nearly 8 times the minimum in 1908. With reservoirs three-quarters full, 2,980 second-feet additional discharge would be furnished for 140 days. With reservoirs full, an increase of 3,710 second-feet would be available for 150 days, making a total discharge of 4,035 second-feet, or over 12 times the minimum in 1908.

Similarly, in 1895, the uniform low-water discharges for the above conditions would have been as follows: reservoirs half full, 2,330 second-feet, or 14.5 times the minimum of 160 second-feet; reservoirs three-quarters full, 3,140 second-feet; reservoirs full, 4,195 second feet, or 26 times the minimum.

That such considerable improvement of low-water flow in the Monongahela is a reasonable estimate will perhaps be emphasized by the fact that a single proposed storage project for water power development, on which detailed surveys and final designs and estimates have been completed, will nearly double the low-water flow of the Monongahela in a year like 1908 and, moreover, deliver this additional discharge daily throughout the year. This project, located on the Big Sandy, a tributary of the Cheat River in West Virginia and Pennsylvania, controls the run-off from only 200 square miles, while

the twenty-two proposed flood control reservoirs control a drainage area of 3,379 square miles, or 46 per cent of the entire Monongahela Basin.

As with the Allegheny, at Pittsburgh, on account of the influence of the navigation dams on gage heights, increases in stage corresponding to the above mentioned increased discharges are not given here, but will be shown in the following chapter.

West Fork of the Monongahela River.

The low-water conditions of the West Fork would be improved from a point about 7.4 miles above Clarksburg to the mouth, a distance of 38.4 miles. There are two reservoir sites proposed on this drainage area, one on the main stream, about 7.4 miles above Clarksburg and one on Elk Creek, which enters the main stream about one-half mile below Clarksburg. The former is included in the Seventeen Selected Projects.

During the 208 days from June 7 to December 31, 1908, the discharge at Enterprise, 12 miles above the mouth, was below 120 second-feet for 179 days. The average discharge for these 179 days was 36 second-feet and it was below 20 second-feet for 13 days, scattered through August, September and October. For several days in September, the discharge was only 14 second-feet, corresponding to a gage height of 0.6 foot.

With the West Fork reservoir half full at the beginning of June, the minimum flow would have been maintained at 120 second-feet, or nearly 9 times the actual minimum, and over 3 times the actual average flow. This increased discharge of 120 second-feet corresponds to a gage height of 1.7 feet, and hence represents an increase in minimum stage of 1.1 feet. With the same reservoir three-quarters full the minimum discharge would not have fallen below 160 second-feet, or gage height 1.8 feet; while if the full capacity could have been reserved for low-water assistance, the minimum would have been maintained above 200 second-feet, or gage height 2.0 feet.

If the Elk Creek reservoir also had been in operation, the minimum discharges and stages would have been as follows: reservoirs half full, 160 second-feet, 1.8 feet; reservoirs three-quarters full, 220 second-feet, 2.1 feet; reservoirs full, 275 second-feet, 2.2 feet. The flood water from these reservoir sites never reaches Pittsburgh before, and generally after flood peak time, and it would be safe to keep them full or nearly so toward the end of the flood season.

Tygart Valley River at Fetterman, W. Va.

Fetterman, W. Va., where a gaging station has been in operation since June, 1907, is about 2 miles downstream from Grafton, and 18 miles above the junction with the West Fork. From June 30 to December 31, 1908, the discharge was below 350 second-feet 150 days, the average being 98 second-feet. For 46 days in October and November, the discharge was 20 second-feet or below, and for 9 days was only 12 second-feet, corresponding to a gage height of 2.3 feet.

None of the Seventeen Selected Projects are located on the drainage of this stream, but five of the forty-three projects are above this point, and their storage would be effective in assisting low-water flow. The flood water from these points always arrives after the Pittsburgh peak and a large percentage of the water impounded by these projects could safely be reserved until needed. With reservoirs half full at the end of June, the flow during these 150 days could have been kept up to 350 second-feet, over 3.5 times the average, and nearly 30 times the minimum. A discharge of 350 second-feet corresponds to a gage height of 3.7 feet, and therefore represents an increase of

1.4 feet in minimum stage. With reservoirs three-quarters full, the discharge could have been maintained at 500 second-feet, corresponding to a stage of 4.0 feet, for the 171 days it fell below this amount; while with reservoirs full, a flow of 600 second-feet, corresponding to a gage height of 4.1 feet, could have been obtained during the 182 days that the actual discharge was less than this rate, this augmented flow amounting to 50 times the minimum, and giving an increase in stage of 1.8 feet. This improvement in the low-water flow would be obtained from the junction with the West Fork up to Dam No. 1 on the Middle Fork River, a distance of about 55 miles.

Youghiogheny River at Connellsville.

All the projects on the drainage area of the Youghiogheny being located above Confluence, the benefit to low-water conditions would extend from this point to the mouth, a distance of about 70 miles. During 1908, the discharge at Connellsville was below 130 second-feet for 109 days, the average for this period being 52 second-feet, while for 9 consecutive days in the latter part of September, the flow was less than 20 second-feet, and the gage read only 0.1 foot.

The Seventeen Selected Projects include only one on this stream, Youghiogheny No. 2, about 13 miles above Confluence. With this reservoir half full at the beginning of August, the flow could have been maintained at 130 second-feet, or over 10 times the minimum, throughout the low-water season, and the minimum stage raised about 0.6 foot. With the reservoir three-quarters full, a constant discharge of 180 second-feet, corresponding to a gage height of 0.8 foot, could have been maintained, while if it had been full, the flow would not have fallen below 210 second-feet, or gage height 0.9 foot.

The forty-three projects include eleven on this basin, all above Confluence. With the assistance of this storage, the discharge and stage at Connellsville could have been maintained at the following amounts: reservoirs half full, 500 second-feet, 1.4 feet; reservoirs three-quarters full, 680 second-feet, 1.7 feet; reservoirs full, 840 second-feet, 1.9 feet, or about 70 times the actual minimum discharge, and 1.8 feet above the minimum stage.

Youghiogheny River at West Newton.

There is no record of the daily discharge of the Youghiogheny River at West Newton, but an estimate of the flow has been made from the records at Connellsville, 24 miles upstream. In 1908, the discharge at West Newton was below 130 second-feet for 109 days between August 13 and December 13, during which period the average flow was 54 second-feet.

With the Youghiogheny No. 2 reservoir half full at the beginning of August, the discharge would have been maintained at 130 second-feet throughout the low-water period. With the reservoir three-quarters full, 180 second-feet would have been the constant low-water flow, while with the reservoir full, a discharge of 210 second-feet would have been maintained.

With the eleven reservoirs constructed, the following constant discharges would have been maintained; reservoirs half full, 500 second-feet; reservoirs three-quarters full, 680 second-feet; reservoirs full, 880 second-feet.

No increases in stage corresponding to the above improved discharges are given, as there is no rating table for the station at West Newton.

INCREASE IN LOW-WATER FLOW OF OHIO RIVER BELOW PITTSBURGH.

The increase in low-water flow shown at Pittsburgh would of course extend down the Ohio, and the amount of this improvement is best shown by a study of the open-channel low-water conditions at Wheeling, W. Va., 90 miles below Pittsburgh.

The discharge at Wheeling in 1908 was extremely low, the low-water extending over a period of about four months near the end of the year. From the middle of August to the middle of December, the discharge was below 5,400 second-feet for 121 days, the average discharge below this amount being 2,508 second-feet. For 10 consecutive days the gage at Wheeling read 0.0 foot, corresponding to a discharge of about 1,600 second-feet.

With the Seventeen Selected Projects constructed and half full at the beginning of August, the flow at Wheeling could have been maintained at 5,400 second-feet, or over 3 times the minimum, during this low-water period. This increased discharge corresponds to a gage height of 2.3 feet and therefore represents an increase in minimum stage of this amount. With reservoirs three-quarters full, a constant discharge of 6,750 second-feet, corresponding to a gage height of 2.8 feet, could have been obtained during the 125 days that the flow was less than this amount. With reservoirs full, a uniform flow of 8,000 second-feet, or 5 times the minimum, could have been maintained for the 136 days that the discharge fell below this amount. With a discharge of 8,000 second-feet, the Wheeling gage reads 3.3 feet, so that, with open-channel conditions, this increase in flow would represent an increase in minimum stage of 3.3 feet.

With the forty-three projects constructed to maximum capacity and half full at the beginning of August, a constant flow of 7,200 second-feet, corresponding to a 3-foot stage, could have been maintained for the 134 days that the discharge fell below this amount. With reservoirs three-quarters full, which is equivalent to keeping empty one-half the flood control capacity of the Seventeen Selected Projects, the flow could have been maintained at 9,350 second-feet, or a stage of 3.7 feet, throughout the low-water season. With reservoirs full, the discharge would not have fallen below 11,200 second-feet, or 7 times the minimum, this increased discharge corresponding to a stage of 4.3 feet, open-channel conditions.

The following tables group the above data in convenient shape for reference and comparison.

TABLE No. 41.

IMPROVEMENT OF LOW-WATER FLOW OF 1908, BY SEVENTEEN SELECTED PROJECTS.

Stream	Station	Distance above mouth (miles)	No. of days below improved discharge	Discharge (second-feet)			Increase in stage (feet)	Length of river improved (miles)
				Average for period	Minimum	Improved by storage		
HALF FULL								
Allegheny ...	Kittanning ...	46	126	1241	850	2900	1.4	139
" ...	Freeport	28	124	1454	950	3400	1.8	...
" ...	Pittsburgh ...	0	124	1500	950	3450	c	...
*Kiskiminetas.	Avonmore ...	21.5	137	166	65	400	0.9	41
Monongahela.	Pittsburgh ...	0	124	a 325	b 325	1125	c	128
West Fork...	Enterprise ...	12	179	36	14	120	1.1	38
Youghiogheny	Connellsville..	44	109	52	11	130	0.6	83
"	W. Newton..	19	109	54	12	130	d	...
Ohio	Wheeling	..	121	2508	1600	5400	2.3	...
¾ FULL								
Allegheny ...	Kittanning ...	46	133	1338	850	3700	1.8	139
" ...	Freeport	28	133	1617	950	4350	2.2	...
" ...	Pittsburgh ...	0	132	1652	950	4400	c	...
Monongahela.	Pittsburgh ...	0	132	a 325	325	1465	c	128
West Fork...	Enterprise ...	12	187	41	14	160	1.2	38
Youghiogheny	Connellsville..	44	119	62	11	180	0.7	83
"	W. Newton..	19	119	62	12	180	d	...
Ohio	Wheeling	..	125	2622	1600	6750	2.8	...

TABLE No. 41.—(Continued.)

IMPROVEMENT OF LOW-WATER FLOW OF 1908, BY SEVENTEEN SELECTED PROJECTS.

Stream	Station	Distance above mouth (miles)	No. of days below improved discharge	Discharge (second-feet) Average for period	Minimum	Improved by storage	Increase in stage (feet)	Length of river improved (miles)
FULL								
Allegheny ...	Kittanning ...	46	139	1490	850	4500	2.1	139
" ...	Freeport	28	138	1760	950	5350	2.6	...
" ...	Pittsburgh ...	0	143	1900	950	5400	c	...
Monongahela.	Pittsburgh ...	0	143	a 325	325	1725	c	128
West Fork...	Enterprise ...	12	200	50	14	205	1.4	38
Youghiogheny	Connellsville..	44	126	68	11	210	0.8	83
"	W. Newton..	19	126	68	12	210	d	...
Ohio	Wheeling	..	136	2984	1600	8000	3.3	...

TABLE No. 42.

IMPROVEMENT OF LOW-WATER FLOW OF 1908, BY FORTY-THREE PROJECTS.

Stream	Station	Distance above mouth (miles)	No. of days below improved discharge	Discharge (second-feet) Average for period	Minimum	Improved by storage	Increase in stage (feet)	Length of river improved (miles)
HALF FULL								
Allegheny ...	Kittanning ...	46	129	1300	850	3400	1.7	139
" ...	Freeport	28	127	1500	950	3850	2.0	...
" ...	Pittsburgh ...	0	128	1580	950	3900	c	...
*Kiskiminetas.	Avonmore ...	21.5	137	166	65	400	0.9	41
Monongahela.	Pittsburgh ...	0	128	a 325	b 325	2500	c	128
West Fork...	Enterprise ...	12	187	41	14	160	1.2	38
Tygart Valley	Fetterman ...	18	150	98	12	350	1.4	55
Youghiogheny	Connellsville..	44	173	134	11	500	1.3	71
"	W. Newton..	19	171	136	12	500	d	...
Ohio	Wheeling	..	134	2916	1600	7200	3.0	...
¾ FULL								
Allegheny ...	Kittanning ...	46	139	1490	850	4400	2.1	139
" ...	Freeport	28	137	1735	950	5000	2.4	...
" ...	Pittsburgh ...	0	140	1835	950	5100	c	...
Monongahela.	Pittsburgh ...	0	140	a 325	325	3305	c	128
West Fork...	Enterprise ...	12	200	50	14	220	1.5	38
Tygart Valley	Fetterman ...	18	171	136	12	500	1.7	55
Youghiogheny	Connellsville..	44	182	157	11	680	1.6	71
"	W. Newton..	19	181	161	12	680	d	...
Ohio	Wheeling	..	146	3380	1600	9350	3.7	...
FULL								
Allegheny ...	Kittanning ...	46	153	1793	850	5350	2.5	139
" ...	Freeport	28	149	2032	950	6050	2.8	...
" ...	Pittsburgh ...	0	150	2126	950	6100	c	...
Monongahela.	Pittsburgh ...	0	150	a 325	325	4035	c	128
West Fork...	Enterprise ...	12	205	55	14	275	1.6	38
Tygart Valley	Fetterman ...	18	182	157	12	600	1.8	55
Youghiogheny	Connellsville..	44	191	176	11	840	1.8	71
"	W. Newton..	19	192	196	12	880	d	...
Ohio	Wheeling	..	158	3891	1600	11200	4.3	...

* Not shown below as it is assumed Black Lick and Loyalhanna reservoirs would not be kept more than half full.

a. Assumed to be same as minimum, as navigation dams prevent measurements of daily discharge.

b. Estimated by Water Supply Commission of Pennsylvania.

c. See Chapter X.

d. No rating curve available.

Table No. 41 shows that, with the Seventeen Selected Projects constructed, 267 miles of the main rivers and 217 miles of tributaries, or a total of 484 miles of stream channels above Pittsburgh would have their low-water discharge considerably increased and made uniform during the dry weather. In addition, there would be a considerable increase in the low-water flow of certain other tributaries, as follows: Tionesta Creek, from dam to mouth, one mile; French Creek, from reservoir on North Branch to mouth, 63 miles; Clarion River, from Dam No. 4 to mouth, 59 miles; Mahoning Creek, from Dam No. 2 to mouth, 21 miles; Cheat River, from Dam No. 2 to mouth, 46 miles. Combined with the figures given above, this would give an improvement extending over 267 miles of main rivers and 386 miles of tributaries, or a total of 653 miles of stream channels above Pittsburgh.

With the forty-three projects constructed, a considerably greater increase of the low-water flow would obtain. In addition to the distance given in Table No. 42, 139 miles, the Allegheny River would have its low-water flow improved from the mouth of Kinzua Creek to Dam No. 1, a distance of 63 miles. Moreover, the following stretches of tributaries, not included in Table No. 42, would receive a considerable addition to their low-water flow: Kinzua Creek, from dam to mouth, 3 miles; Tionesta Creek, from dam to mouth, one mile; French Creek, from North Branch reservoir to mouth, 63 miles; East Sandy Creek, from Dam No. 2 to mouth, 2 miles; Clarion River, from Dam No. 4 to mouth, 59 miles; Red Bank Creek, from mouth of North Branch to mouth, 43 miles; Mahoning Creek, from Dam No. 2 to mouth, 21 miles; Buffalo Creek, from dam to mouth, 12 miles; Youghiogheny River, from Dam No. 5 to Dam No. 1, 33 miles; Casselman River, from Dam No. 5 to mouth, 11 miles; Laurel Hill Creek, from dam to mouth, 5 miles; Cheat River, from Shavers Fork Dam No. 2 to mouth, 93 miles; Buckhannon River, from dam to mouth, 8 miles; Middle Fork River, from Dam No. 1 to Dam No. 2, 5 miles; Elk Creek, from dam to mouth, 6 miles. This improvement would therefore extend over 393 miles of main rivers and 570 miles of tributaries, or a total of 963 miles of stream channels above Pittsburgh.

The increase in low-water flow would extend down the Ohio to Wheeling, a distance of 90 miles, and many miles below. The resultant benefits to navigation, sanitation, water supply and water power are naturally very considerable and will be discussed in the following chapters.

CHAPTER X.

RELATION OF STORAGE RESERVOIRS TO NAVIGATION.

Extent of Present Navigation—Character and Amount of Water-borne Tonnage—Benefits of Increased Discharge to Navigation—Monongahela — Youghiogheny—Allegheny — Ohio — Increase in Stage due to Storage Reservoirs—Benefits of Reduced Flood Stages to Navigation.

EXTENT OF PRESENT NAVIGATION.

The cheap transportation afforded by the navigable rivers above and below Pittsburgh is of tremendous importance commercially and industrially not only to Pittsburgh, but to the entire Ohio Valley, and even to the trade centers of the Mississippi Valley. The Monongahela is slackwatered from its mouth to a point on the West Fork about 4 miles above Fairmont, W. Va., or a total distance of 131 miles; the Allegheny has slackwater navigation from its mouth to Natrona, a distance of 24 miles; while the Ohio, with the assistance of the few locks and dams already constructed, is navigable, except at low water and during parts of the winter season, throughout the 967 miles from Pittsburgh to Cairo, and within a comparatively few years, according to present plans, will be completely canalized.

CHARACTER AND AMOUNT OF WATER-BORNE TONNAGE.

It is notable that while there has been a manifest decrease in water-borne traffic on a majority of the rivers and inland waterways of the country, the aggregate tonnage on the Ohio has been well maintained, and on the Monongahela, has steadily increased, reaching in 1907, about 12,000,000 tons. The total volume of traffic on the Ohio and Monongahela Rivers is estimated at about 25,000,000 tons annually. The principal cargo is coal, about 70 per cent of which is consumed in the Pittsburgh district. The movement of sand and gravel has increased considerably and is next in importance to that of coal. The importance of the navigation on the Monongahela to the Pittsburgh district is emphasized by the fact that more than half the coal to Pittsburgh is carried by water, while of the total coal tonnage to and through Pittsburgh, about 30 per cent is by river.

About 37 per cent of this coal is moved by one large company, and the balance by a number of smaller coal companies, and by the boats of several large corporations which maintain very efficient fleets for bringing the coal from their mines along the Monongahela to their mills. The barges are handled in comparatively small tows at Pittsburgh and above, but when destined for points lower down the Ohio or Mississippi, they are assembled in fleets carrying from 12,000 to 20,000 tons; while after passing the Falls of the Ohio, at Louisville, the fleets are enlarged to from 35,000 to 50,000 tons, and carried downstream by larger towboats. It is stated that coal has been shipped in these fleets from Pittsburgh to New Orleans at a rate less than 0.4 mill per ton-mile.

The boats used in the coal trade are divided by the river men into two classes: (1) coal barges, 135 feet long, 26 feet beam and 8½ feet deep, costing $1,600, carrying 550 short tons of coal and employed mainly in the trade to Cincinnati, Louisville and other Ohio River points; (2) coal boats, 175 feet long, 26 feet beam and 10 feet deep, costing $850, carrying from 1,000 to 1,200 tons and employed chiefly

in the "long-river" trade to New Orleans, where they are sold for firewood, etc. The decked barges used for carrying down steel, nails, wire, etc., and for bringing back molasses, sugar, lumber, etc., are 225 feet long, 36 feet beam and 10 feet deep, costing from $6,000 to $20,000. The use of steel barges on the Ohio River coal trade is as yet only experimental, but a number have been built by one of the large corporations and they are claimed to give excellent service. It is maintained by experienced river men that the fixed charges and maintenance cost are so great as to make their economical use impracticable; but it is believed that this is only because, under present river conditions, the average number of trips to the southern market is only 1.8 per year, and that when the improvement of the Ohio by locks and dams is completed, steel barges will doubtless come widely into use.

The towboats are of various sizes, the largest being about 500 tons and having 1,000 horsepower. They are all of the stern-wheel type, with the boiler room and stacks well forward. There are generally two stacks, placed abreast of each other, with sway bracing between, and hinged so that they can be lowered in case of insufficient clearance under bridges.

In addition to the bulk traffic above described, there are about fifteen important packet lines transporting passengers and general merchandise on the Monongahela and Ohio Rivers. These lines operate a total of about 50 steamers, and in addition there are numerous boats on the Ohio owned by individuals, including many gasoline boats.

The tonnage moved on the Monongahela and Ohio is certain to steadily increase. There are vast coal deposits yet to be mined in the territory tributary to these waterways. The canalization of the Ohio and the construction of a canal between the Great Lakes and the Ohio River will tend to cause the movement of an increasing percentage of this coal by water, as well as to create a large water-borne tonnage of iron ore and other commodities.

BENEFITS OF INCREASED DISCHARGE TO NAVIGATION.

Monongahela River.

Under present conditions there are serious troubles with shortage of water on the Monongahela River during dry weather. The pools in the summer and early fall are drawn down considerably below the crest of the dams, owing to evaporation and losses through leakage and lockages, and the steamers plying the rivers between Pittsburgh and Fairmont are frequently obliged to suspend operations.

The limiting draft at low water is no longer governed by the depth at the lock sills, these having been lowered, but is at the shallow places in certain of the pools, where there is said to be only about five feet of water when the pools are drawn down. The movable tops were placed on the Monongahela dams to store more water between lockages at times of low water, as well as to give more depth over these shoal places. When it happens that these movable tops are not raised in time in the dry weather, there is not enough water flowing to fill the pools. At such times the pools furthest upstream are drawn down to furnish water for the pools nearer Pittsburgh, and through navigation is impossible, the upper pools being sometimes lined with barges waiting for water to float them down stream.

With an increase in the amount of commerce on the Monongahela, this shortage of water during dry weather will be of longer duration and more severely felt. The average number of lockages per day at Dam No. 1, Monongahela, during September, 1908, when the drought was at its height, and navigation was seriously hampered by inade-

quate water supply, was about 40. At that time, the old locks, 250 feet by 56 feet, and 190 feet by 50 feet, were in use, and these lockages were divided about equally between the two locks. The new lock, in use since June 1, 1910, is 360 feet by 56 feet. Forty lockages with the average of the old locks would therefore be equivalent to only 23 lockages with the present lock. As one lockage with the present lock represents the expenditure of only 1.36 second-feet of discharge, the total discharge consumed in lockages in September, 1908, assuming that the locks had to be emptied and filled for each lockage, was therefore only about 31.3 second-feet, or a relatively small part of the total low-water flow of the Monongahela at that time. It is very evident from these figures that, on account of leakage, evaporation and other losses, a much larger flow than merely the actual lockage water is required in order to maintain pool-full navigation on the Monongahela.

The ten-day period with the greatest number of lockages since the new lock went into service occurred in June, 1910, when an average of about 37 lockages per day, or about one and one-half times the average daily lockage in September, 1908, was recorded. If this daily demand upon the locks had existed in the late summer and fall of 1908, the shortage of water would undoubtedly have been a much greater hindrance to the river traffic than it was.

When it is taken into consideration, however, that with pools full and adequate water supply, the present lock at Dam No. 1, Monongahela can readily make 90 lockages a day, if the traffic demands; and that the second lock, now under construction, will double this figure, and bring the discharge necessary for lockage purposes up to 244 second-feet, or nearly eight times the amount that was required in September, 1908, it becomes evident that, if commerce on the Monongahela ever becomes great enough to operate the locks to their full capacity, the shortage of water will be so very severely felt that the construction of storage reservoirs to increase the dry-weather flow will become an absolute necessity.

For even assuming that there were no water losses, and that all the discharge were available for lockage purposes, the maximum movement of traffic through the locks at Dam No. 1 would require more lockage water than the low-water flow of the river provides. The Reports of the Chief of Engineers of the United States Army give the minimum discharge of the Monongahela as 160 second-feet, which occurred in 1895, the dryest season in recent years. This is only about two-thirds of the discharge of 244 second-feet necessary to supply water for 180 lockages, even if there were no other losses.

The Monongahela River is extensively used as a source of water supply, expecially for industrial purposes. The daily pumpage is enormous, and while the greater part of this water is returned to the river, the amount permanently withdrawn is a considerable factor in reducing the low-water flow.

The minimum flow of 160 second-feet is equal to 103,403,520 gallons per day. There are about 505,230,000 gallons per day pumped from the Monongahela below Fairmont for domestic and industrial purposes, or nearly five times the minimum discharge. If these various pumping plants were operated to full capacity, they would pump about 922,000,000 gallons per day, or about nine times the minimum discharge. It is estimated that about 45,707,500 gallons, equal to 9 per cent of the amount actually pumped, or to 44 per cent of the minimum discharge, is permanently withdrawn from the river, the balance being returned after use.

The loss by evaporation is also a considerable factor in reducing the low-water discharge. The slack-water pools form a stretch of quiet water, averaging about 650 feet

in width, for the 127 miles from Pittsburgh to Fairmont. It is estimated that the daily evaporation during the hot, dry season is at least 0.25 inch, which would mean a total evaporation between Pittsburgh and Fairmont of 105 second-feet, equal to 65.5 per cent of the minimum flow.

The minimum discharge of 160 second-feet represents, of course, the net discharge, i. e., the discharge minus losses due to evaporation and to water being permanently withdrawn for various purposes. It is therefore equal to the water used for lockages, plus the leakage through and under the navigation dams. As stated, the water consumed in lockages during the height of the drought in 1908 was only about 31 second-feet, while the Water Supply Commission of Pennsylvania, in its Annual Report for 1908, gives the minimum discharge of the Monongahela during 1908, as 325 second feet; so that the loss through leakage must have been 294 second-feet.

As an example of the losses resulting from the interference of low water with navigation, the following figures relating to coal carried by water for use in the Pittsburgh district alone are significant. About 23,000 tons of coal per day are moved by river for consumption in the Pittsburgh district at a cost of about $0.04 per ton. To move this coal by rail would cost about $0.45 per ton. In 1908, owing to the fact that during 45 days of the low-water season barges had to be loaded to a less draft, it cost about $0.12 per ton to move this coal by water, or about $0.08 above the cost with pool-full navigation. This represents an additional expenditure of about $83,000 for moving this coal in one year.

If the Seventeen Selected Projects were constructed, the storage that would be available for navigation assistance in the four reservoirs of this group located on the Monongahela Basin would increase the low-water flow of the Monongahela to 6 times its present minimum. If all 22 of the projects located on the Monongahela Basin were constructed to maximum capacity, the dry-weather flow would be maintained at a constant amount of about 19 times the present minimum. Under these conditions, an adequate water supply would be at all times available, and all the above described troubles during the low-water season would disappear.

Youghiogheny River.

The construction of locks and dams on the Youghiogheny River between the mouth and West Newton, a distance of 18 miles, has been several times under consideration by the United States Government. The River and Harbor act of June 25, 1910, provided for the canalization of this portion of the river by the construction of three locks and dams at an estimated cost of $1,050,000. No actual construction work has as yet been started on this project, but when these locks and dams are built, the present low-water flow will be inadequate to maintain pool-full navigation. With only the Seventeen Selected Projects constructed, the portion of this storage located on the Youghiogheny, as already shown, would increase the minimum flow to 10 times its present amount at West Newton and would insure uninterrupted navigation at all times. With all 43 projects constructed, the storage in those projects located on the Youghiogheny would increase the minimum discharge at West Newton to about 38 times its present amount.

Allegheny River.

At present only 24 miles of the Allegheny, between Pittsburgh and Natrona, are slackwatered. Plans for extending the canalization of the river to Oil City, 134 miles above Pittsburgh, have been prepared by the government engineers, and the construction of the locks and dams is being urged by those interested. As already shown,

the storage proposed in the 13 of the Seventeen Selected Projects located on the Allegheny Basin would increase the low-water stage between Oil City and Pittsburgh by about 1.4 feet, while if all 43 projects were built, the 21 reservoirs located on the Allegheny Basin would give an increase in minimum stage of about 2.0 feet. This would greatly improve the present intermittent open-river navigation above Tarentum. In the event of the extension of the slackwater system further up the river, moreover, such an increase in low-water stage would reduce the number of locks and dams required, and would insure a pool-full stage and uninterrupted navigation throughout the year.

Ohio River.

The proposed improvement of the Ohio to give a nine-foot stage from Pittsburgh to Cairo by means of locks and dams involves the ultimate construction of 54 dams at an estimated cost of $63,731,488, in addition to the amount appropriated and authorized prior to March 2, 1907, or a total cost of $73,012,864. Up to August 1, 1911, 12 of these dams had been completed and 11 others were under construction.

The Ohio River has a succession of natural pools formed by bars of sand and gravel, and sometimes of solid rock. Under present conditions the troubles and delays to navigation are caused chiefly by insufficient depth on these bars during low water. As a result, during the low-water season, it is necessary to assemble the loaded coal barges in the pools near Pittsburgh and wait for a rise that will give a boating stage through the open portion of the river. This results in a considerable loss due to loaded steamers and barges lying idle, sometimes for many weeks. It also makes it necessary, during these periods, to ship coal to down-river points by rail at a cost of from 8 to 10 times the rate by water.

The following is quoted from an address delivered November 29, 1904, by Mr. John E. Shaw, before the Merchants and Manufacturers Association:

"In June, 1895, there were collected in the Pittsburgh Harbor 1,200,000 tons of coal loaded on about 2,500 vessels, awaiting water to move down the Ohio River, the largest tonnage ever assembled in any harbor in the world at one time. The rise did not come until November 27th. The cost of freight and vessels engaged in the service was estimated at $6,310,000. It cost $2,000 per day to keep the tonnage afloat, and $1,000 per day interest on the investment; total, $3,000 per day. This tonnage was kept waiting in Pittsburgh Harbor for water in the Ohio River an average time of five months, or one hundred and fifty days, at a loss of $450,000, which is 5 per cent on $9,000,000."

At the convention of the Ohio Valley Improvement Association, held in Louisville, Kentucky, in October, 1908, Mr. George W. Theiss, President of the Monongahela River Consolidated Coal and Coke Company, in speaking of the losses due to low water on the Ohio River, stated that at that time there were about 1,100 loaded coal barges lying at Pittsburgh, containing about 770,000 tons of coal, mined at a cost of about $962,000; that including those loaded at Pittsburgh, about 2,300 barges, representing a value of $1,800,000, were tied up along the Ohio river; that from 75 to 80 steamboats, representing an investment of about $3,000,000, were lying idle; that freight barges, worth from $300,000 to $400,000, were idle; that shippers of manufactured steel products had a tonnage aggregating $800,000 lying idle; a total capital of something over $6,862,000 lying idle because of low-water conditions in the Ohio River. The loss per day during this long drought, taking into account interest and depreciation, harbor expenses, wages and care of idle mines, amounted to about $5,200. With these conditions existing for six months, or 180 days, the actual expense and waste of money amounted to at least $936,000, or, at 5 per cent, the interest on $18,720,000.

Another serious loss is due to the fact that the intermittent character of the navigation on account of low water requires a much larger equipment for a given amount of business than would be necessary with continuous navigation. As already stated, under present river conditions, the average number of trips per barge to the southern market is only 1.8 per year. That is, a barge worth $2,000 carries to market annually an average of 990 tons of coal. The expense of maintaining the barge, including interest and depreciation, is about $0.25 per ton of cargo carried, which must be added to the price of coal in the southern market. It was stated by the above authority that, with continuous navigation, the present river tonnage could be carried with from one-third to one-half the equipment now necessary, and the cost of transporting coal by water reduced perhaps as much as 50 per cent.

It has already been shown that if the Seventeen Selected Projects were constructed to flood control capacity and were half-full at the beginning of the low-water season, the present minimum stage under open-river conditions at Wheeling could be increased 2.3 feet. If, in addition to this, the additional storage found available were constructed for improvement of the low-water flow for navigation and other purposes, the increase in stage at Wheeling would be 3.7 feet.

The benefits to navigation resulting from such an increase in low-water flow would be very great, not only with present open-river conditions but also when the construction of the locks and dams is completed. The increased discharge would supplement the slackwater system and insure uninterrupted pool-full navigation throughout the year. It is certain, moreover, that with this increased depth it would be possible to obtain the desired nine-foot navigation with fewer locks and dams.

INCREASE IN STAGE DUE TO STORAGE RESERVOIRS.

The effect of storage reservoirs in increasing the stage and discharge at various points on the Allegheny, Monongahela and Ohio Rivers has been fully described in the preceding chapter. In order to bring out in a somewhat different manner, however, the possibilities of improving navigation facilities by the increased flow and higher stages in the three rivers at Pittsburgh, due to reservoir assistance during low water, the following tables, Nos. 43 and 44, have been prepared. The relative value of the various groups of reservoirs in increasing low-water flow and stages is brought out in these tables and in the diagram on Plate 86.

These tables and the diagrams are figured as if the natural flow of the rivers kept the pools full to the crests of the dams, in which case the increase in stage due to artificial flow from the reservoirs would be equal to the head on the dam crests corresponding to the respective artificial discharges furnished by the storage reservoirs. In these calculations, the ordinary Francis formula for weir discharge, namely, $Q = 3.33\,BH^{\frac{3}{2}}$, has been employed, where B represents the length of dam crest in feet, and H the head in feet over crest at time of discharge Q. The diagram, Plate 87, shows the discharge curves for Davis Island, Herr Island and the Monongahela No. 1 dams, as figured from the above formula.

It is not considered that the increase of gage heights by each group of reservoirs would actually obtain as shown on Plate 86, for changes in conditions of actual flow would to a certain extent increase or decrease the estimated effects of the additional discharge furnished by storage; but the results are believed to be accurate within reasonable limits, and to show the great possibilities of assisting navigation with stored water. It is obvious that, in the actual manipulation of the reservoirs, they would not

TABLE No. 43.

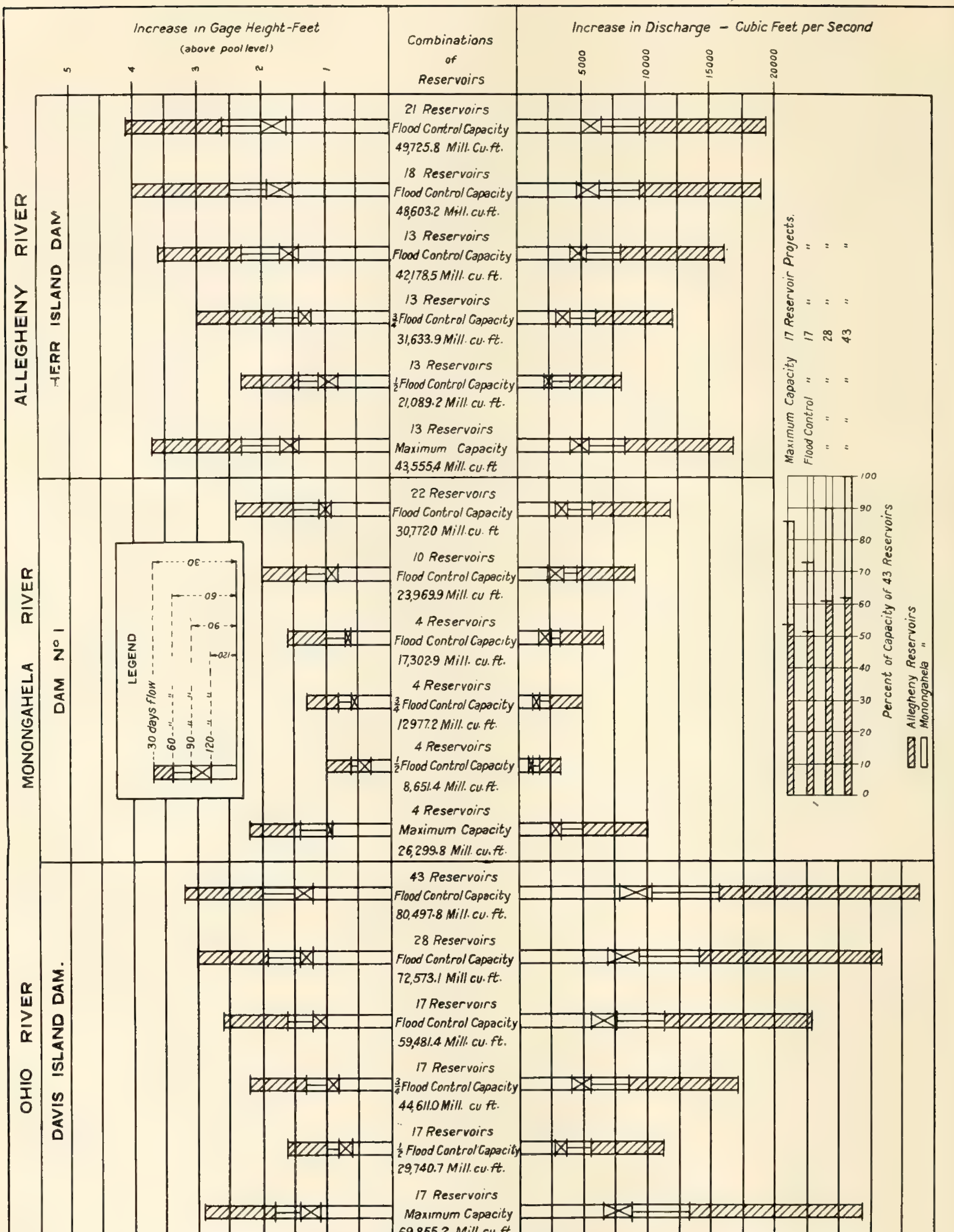
INCREASED STAGE AND DISCHARGE OF ALLEGHENY, MONONGAHELA AND OHIO RIVERS AT PITTSBURGH WITH SEVENTEEN SELECTED PROJECTS—FLOOD CONTROL CAPACITY.

Duration of increased stage	Allegheny River Lock No. 1 (Herr Island)						Monongahela River Lock No. 1						Ohio River Davis Island dam					
	Reservoirs full		Reservoirs ¾ full		Reservoirs ½ full		Reservoirs full		Reservoirs ¾ full		Reservoirs ½ full		Reservoirs full		Reservoirs ¾ full		Reservoirs ½ full	
	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge
Days	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
30	3.6	16270	3.0	12200	2.3	8140	1.6	6670	1.3	5000	1.0	3330	2.6	22940	2.2	17200	1.6	11470
60	2.3	8130	1.8	6100	1.4	4070	1.0	3330	0.8	2500	0.6	1670	1.6	11460	1.3	8600	1.0	5740
90	1.7	5420	1.4	4070	1.1	2710	0.7	2220	0.6	1670	0.5	1110	1.2	7640	1.0	5740	0.8	3820
120	1.4	4070	1.2	3050	0.8	2040	0.6	1670	0.5	1250	0.3	830	1.0	5740	0.8	4300	0.6	2870

TABLE No. 44.

INCREASED STAGE AND DISCHARGE OF ALLEGHENY, MONONGAHELA AND OHIO RIVERS AT PITTSBURGH WITH VARIOUS COMBINATIONS OF RESERVOIRS.

Duration of increased stage	Allegheny River Lock No. 1 (Herr Island)						Monongahela River Lock No. 1						Ohio River Davis Island dam					
	Flood control capacity				Maximum capacity 13 projects		Flood control capacity				Maximum capacity 4 projects		Flood control capacity				Maximum capacity 17 projects	
	21 projects		18 projects				22 projects		10 projects				43 projects		28 projects			
	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge	Rise in stage	Additional discharge
Days	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
30	4.1	19590	4.0	19160	3.7	16800	2.4	11870	2.0	9240	2.2	10150	3.2	31460	3.0	28400	2.9	26950
60	2.6	9780	2.5	9580	2.3	8400	1.5	5940	1.3	4620	1.4	5080	2.0	15720	1.9	14200	1.8	13480
90	2.0	6530	1.9	6390	1.7	5600	1.1	3960	1.0	3080	1.0	3390	1.5	10490	1.4	9470	1.4	8990
120	1.6	4890	1.5	4790	1.4	4200	0.9	2960	0.8	2310	0.9	2540	1.2	7850	1.2	7100	1.1	6740



FLOOD COMMISSION — PITTSBURGH, PENNA.

DIAGRAM SHOWING

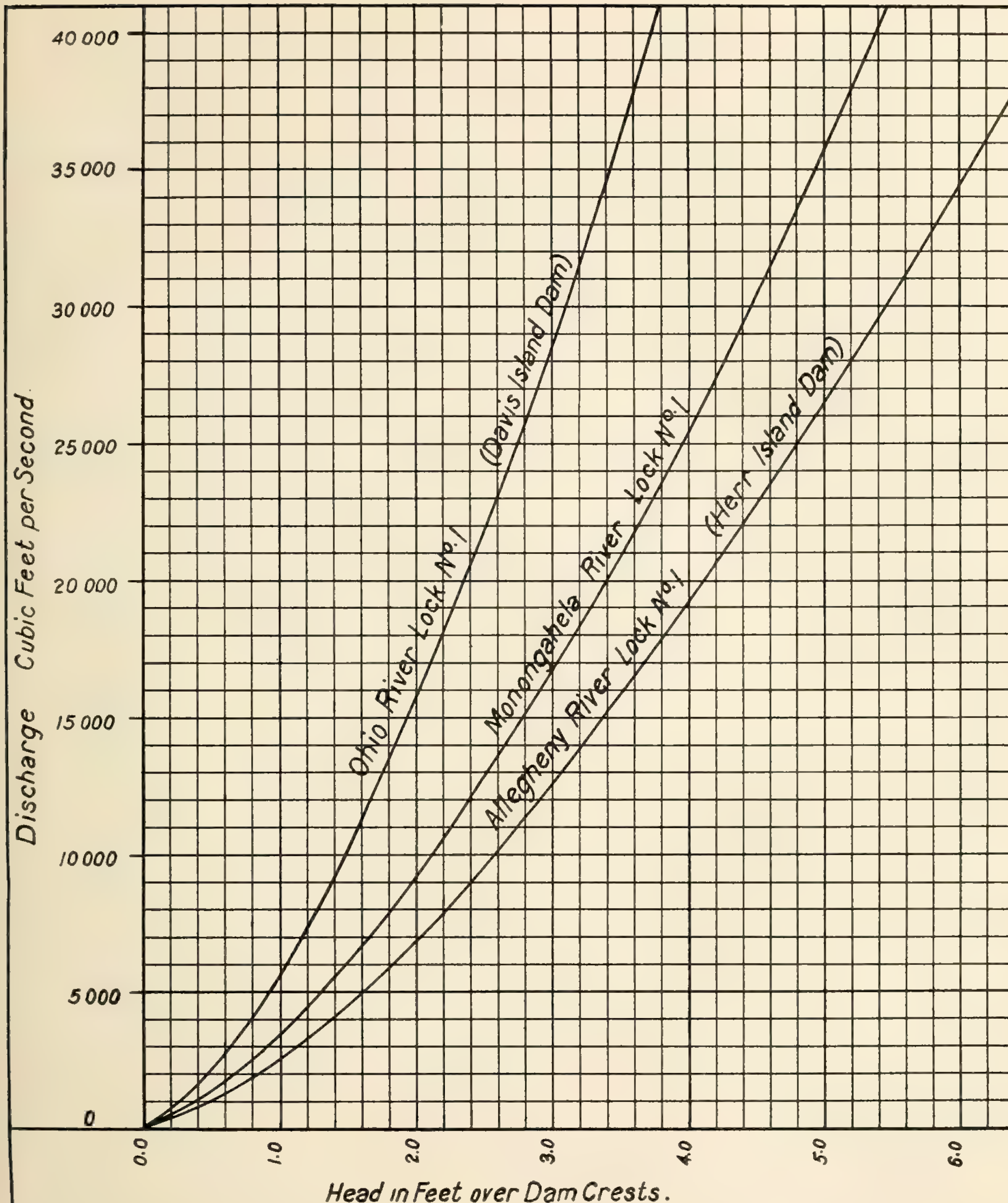
RELATIVE INCREASE IN STAGE AND DISCHARGE

AT

HERR ISLAND DAM, DAM No. 1 — MONONGAHELA RIVER, AND DAVIS ISLAND DAM

BY

STORAGE RESERVOIRS IN VARIOUS GROUPS



FLOOD COMMISSION
PITTSBURGH PENNA.

DIAGRAM SHOWING
DISCHARGES AND CORRESPONDING DEPTHS
OVER
CRESTS OF DAMS

Formula: $Q = 3.33\, B\, H^{\frac{3}{2}}$

be required to deliver their water in this way. The assistance to low-water flow would start with the release from the reservoirs of only a small amount of water, because the natural stage of the river would drop below the required stage only gradually.

It is evident, however, that the diagram shows accurately the relative importance of the various groups of reservoirs in improving low-water stages and discharges in the three rivers. For example, it is clear from the diagram that the Seventeen Selected Projects, with flood control capacity, would produce a very large proportion of the increased flow to be obtained from all forty-three reservoirs; and that this proportion would be but very little increased in the Allegheny River and largely increased in the Monongahela River, by constructing the reservoirs to maximum capacity.

BENEFITS OF REDUCED FLOOD STAGES TO NAVIGATION.

There would be a great improvement in the condition of the rivers for navigation purposes with the reduction in flood heights that would be obtained by the storage reservoirs. For example, the reduction in the velocity of the current, due to a lowering of the high stages, would greatly facilitate the safe handling of river traffic. During high stages in the rivers, boats under way have to be handled with great care on account of the swift current, while at the highest stages navigation is practically suspended. Steamers, barges and other river craft at moorings during floods must put out extra lines and be carefully guarded, not only against the danger of breaking away themselves but also because of the possibility of other boats above breaking away from their moorings and bringing up against them.

Moreover, the wide fluctuations in water levels at Pittsburgh, Wheeling, Cincinnati and other river ports are a serious drawback to the expeditious and economical handling of cargoes to and from river boats. It has been shown in the chapter on Flood Protection, that if a method of flood relief involving no lowering of flood levels by storage reservoirs should be adopted, and the floods kept in the river channels by means of protection walls along the river front, the necessary walls would be so high above pool level that it would be an expensive and difficult matter to provide convenient approaches to the river front slopes as now used for loading and unloading river boats. If the channel were dredged and the boats brought alongside the wall, this difficulty would be eliminated, but it would still be less convenient than the low wall that could be built if flood levels were lowered by storage reservoirs, because there would be greater fluctuations of water levels and a greater vertical distance to raise and lower cargoes.

But one of the most important benefits that would result from the reduction in flood heights would be the increased clearances under the river bridges during high water, particularly under those crossing the Allegheny River at Pittsburgh. This increase in head-room would be a benefit to navigation by reducing to a minimum the number of days when river boats are unable to pass under the bridges; it would also be a very considerable benefit to the traffic over the bridges, in that it would reduce to a minimum the amount that the bridges may have to be raised to avoid interference with river traffic.

The matter of raising the Allegheny River bridges has three times been reported upon by the United States Engineers, and three plans have been recommended, and approved by the Chief of Engineers, and then disapproved by the Secretary of War.

The following tables, Nos. 45 and 46, show the clearances of the Allegheny and Monongahela bridges above pool level, above the actual crest of the 1907 flood, and above the estimated crest as reduced by reservoir storage. In the table for the Al-

legheny River are also given the clearances with the bridges raised the amount most recently recommended by the United States Engineers.

TABLE No. 45.

CLEARANCES OF BRIDGES OVER ALLEGHENY RIVER.

Bridge	Clearance above Pool		Clearance above 1907 flood		Clearance above 1907 flood reduced by reservoir storage	
	Present	Proposed	Present	Proposed	Present	Proposed
6th St.	32.0	47.0	2.5	17.5	12.3	27.3
7th St.	35.0	47.1	5.3	17.4	15.1	27.2
9th St.	33.6	47.3	3.8	17.5	13.6	27.3
P. F. W. & C. Ry.	34.9	47.5	4.9	17.5	14.7	27.3
16th St.	31.9	48.2	1.4	17.7	10.9	27.2
30th St.	36.0	44.0	12.5	19.5	20.5	28.5
Junction R. R.	34.4	44.0	9.4	19.0	18.7	28.3
43rd St.	27.7	44.0	2.2	18.5	10.9	27.2
Sharpsburg	52.4	....	25.7	....	33.9	....
Highland Park	74.0	....	46.5	....	54.5	....

TABLE No. 46.

CLEARANCES OF BRIDGES OVER MONONGAHELA RIVER.

Bridge	Clearance above Pool	Clearance above 1907 flood	Clearance above 1907 flood reduced by reservoir storage	Bridge	Clearance above Pool	Clearance above 1907 flood	Clearance above 1907 flood reduced by reservoir storage
Point	70.0	41.0	50.8	South 22nd St.	53.7	26.7	36.6
Wabash R. R.	70.0	40.6	50.3	Monon. Conn. R. R.	51.0	23.4	33.1
Smithfield St	51.0	21.5	31.0	Glenwood	57.2	27.2	37.1
P. C. C. & St. L. Ry.	51.0	21.4	30.8	B. & O. R. R.	54.6	24.5	34.5
South 10th St	55.0	25.0	34.3				

It will be noted in Table No. 45, that even if the Allegheny bridges are raised to the proposed heights, in floods like that of 1907, there will still be about 10 feet of clear head-room lacking for boats 28 feet high, such as are ordinarily used on the Monongahela, providing they were likely to be under way during the dangerous period of navigation on the crest of such a high flood. With reservoir control, however, 28 feet of clearance would be available practically at all times; while the reduction in stage and velocity would reduce the danger and difficulties of navigation to a minimum.

In Table No. 46, it will be noted that, in the 1907 flood, with the exception of the Point and Wabash Railroad bridges, which have 70 feet of clear head-room above pool, all the Monongahela bridges lacked clearance for a boat 28 feet high. With reservoir control, however, there would be ample clearance for a boat 32 feet high, except for a short time at two of the bridges.

This problem was made the subject of an exhaustive study and report by Col. Thomas W. Symons and Frederick Law Olmsted, prepared under the direction of the Pittsburgh Civic Commission, in the spring of 1910.

After going carefully into a comparison of the traffic over and under the bridges, the average number of days per year in the past 53 years when existing types of river craft were unable to pass under bridges of the present and various assumed clearances, and the changes in grades of approaches and abutting property involved with raising

to various heights, together with the resulting increase in tractive force required for hauling over these respective grades, this report recommended that, if the bridges were to be changed, the elevations should be fixed so that there would be a clear head-room of 37 feet above pool level, or a gage height of about 6 feet at the Point, varied so as to give at each bridge a clear head-room of 28 feet when the river is at a 15-foot stage.

The present clearance of the Sixth Street bridge above pool level is 32 feet. The above report found that, in the past 53 years, there have been an average of 57 days per year when the ordinary Monongahela boats, 28 feet high, could not pass under the bridge. The proposed system of storage reservoirs, had it been in operation during this period, would have so lowered flood stages that there would have been, on the average, only 3 days per year when boats of this size could not pass the bridge.

If the Sixth Street bridge were raised to give a clearance of 37 feet above pool level, as recommended in the report of the Civic Commission, the average number of days per year, based on the records of the past 53 years, when boats could not pass, would be 12 days for boats 28 feet high, and 57 days for boats 32 feet high. With reservoir control these figures would be reduced to 1 and 3 days, respectively.

The clearance recommended by the United States Engineers for the Sixth Street bridge is 47 feet above pool level. With the bridge raised to this elevation there would be an average of about one day per year when boats 32 feet high could not pass, which is practically the same condition as would obtain if the bridge were raised to give 37 feet clearance above pool, and floods were controlled by storage reservoirs. In other words, the proposed reservoir system would reduce by 10 feet the clearance considered necessary by the United States Engineers.

The above statements are based on the heights of existing types of river boats. Serious attention has been given to the question of modifying the design of these boats. Hon. D. S. Alexander, Chairman of the Rivers and Harbors Committee of the United States House of Representatives, in submitting for action of the House the last River and Harbor bill, on February 11, 1910, recommended in his report that the Government carry on experiments with a view to improving the present type of river craft, but little changed since 1860; and expressed the opinion that such experiments might develop a type of river freight carrier that would decrease costs of transportation and also "reduce the cost of all bridges across navigable streams due to lessened requirements in the matter of head-room."

During the summer of 1911, two members of the United States Engineer Corps visited the principal European countries and examined the types of vessels used on the rivers, with a view to determining the best design for river boats in this country. If these and other studies and experiments should develop a type of river boat of 28 feet height or less, no changes in the present bridge heights would be necessary, provided the system of flood control reservoirs were constructed.

CHAPTER XI.

RELATION OF STORAGE RESERVOIRS TO SANITATION AND WATER SUPPLY.

Introduction—Dilution of Sewage—Reduction of Hardness by Dilution—Saving in Soap—Treatment for Industrial Uses—Saving in Reagents—Reduction of Acidity by Dilution—Pittsburgh Filtration System—Benefits of Reduced Flood Stages—Conclusion.

INTRODUCTION.

The Allegheny, Monongahela and Ohio Rivers are extensively used as a source of water supply for domestic and industrial purposes. Their waters are dangerously polluted with the sewage of thickly populated valleys and impregnated with mine drainage and manufacturing wastes. In addition, the hardness of the water requires its treatment in water-softening plants before its use for steaming purposes, and this quality at certain times of the year is sufficiently marked to become objectionable where the water is used for domestic purposes. An increase in the low-water flow of the rivers by releasing the impounded flood waters would very greatly improve these conditions, as will be shown in the following pages.

DILUTION OF SEWAGE.

It is evident that the improvement of the condition of the rivers through dilution of their sewage burden at times of low-water would be considerable At Pittsburgh, for example, where a combined population of about 583,000 discharges sewage into the rivers, the minimum Ohio River flow of about 1200 second-feet is only about 2 cubic feet per second per 1000 of population, whereas the minimum dilution considered permissible, if nuisance and odor are to be avoided, is usually taken at 3.33 cubic feet per second for each 1000 persons contributing to such sewage discharge. With the lowest estimate of the increased flow that could be obtained by the storage reservoirs, this minimum dilution would be about 8 cubic feet per second per 1000 inhabitants.

On the Allegheny, at Kittanning and Freeport, as has been shown, the minimum flow would be over three times its present amount; and on the Kiskiminetas, at Avonmore, it would be six times the present minimum discharge. On the Monongahela, at Pittsburgh, the minimum discharge would be six times its present amount; and on the Youghiogheny, at West Newton, nearly ten times its present minimum flow. The sewage of practically all the towns bordering these rivers passes into the streams without purification, and the conditions, owing to the concentration of sewage and other wastes during low water, are yearly becoming more serious. Such an increase in low-water flow would very considerably dilute this sewage and greatly improve the quality of the water for domestic and industrial supply, even though no complete purification of sewage be provided.

REDUCTION OF HARDNESS BY DILUTION.

The hardness of the Allegheny and Monongahela River waters is due mainly to the presence of sulphates and carbonates of calcium and magnesium, gathered by the water as it flows through or over the ground into the water courses. As the hardness is greatest during the low-water period, when the impounded flood water would be gradually re-

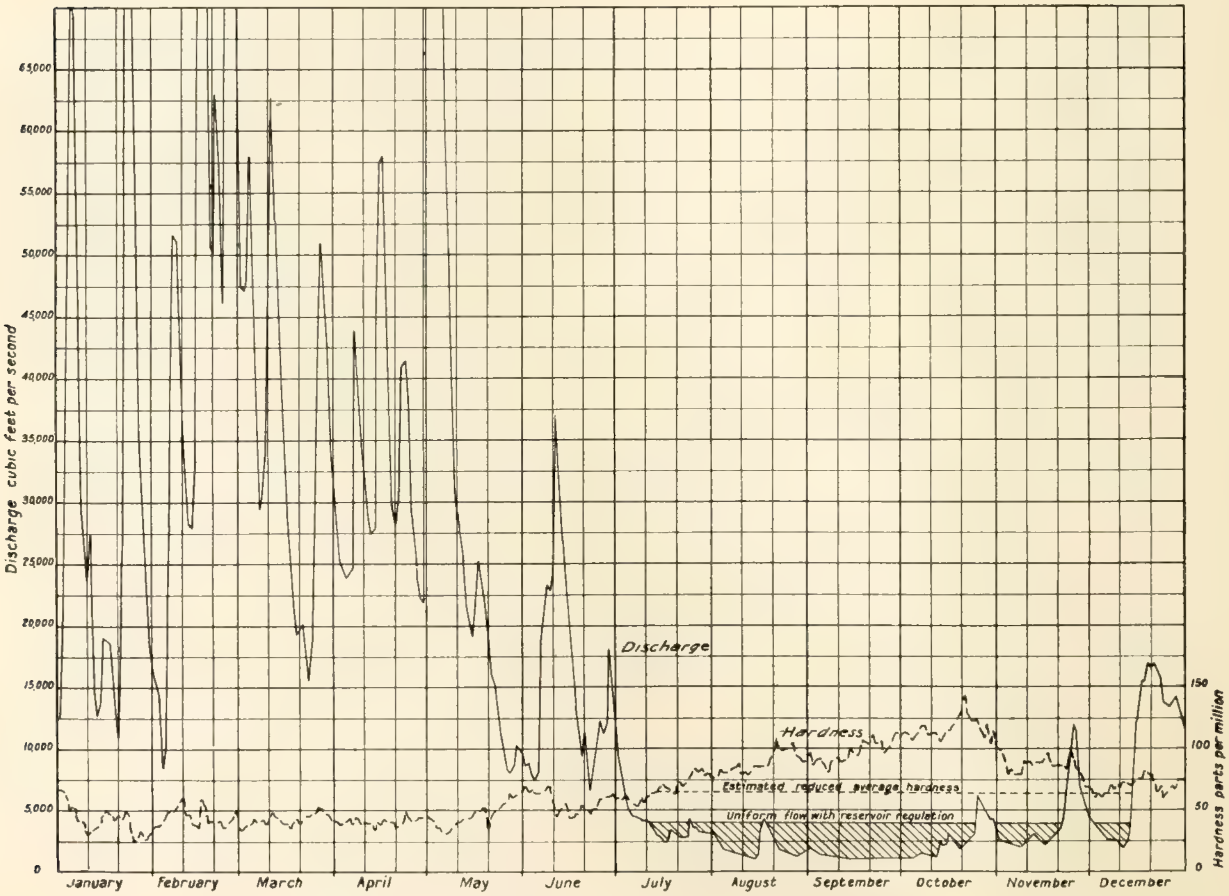
leased from the reservoirs, there would evidently, by this means, be a considerable reduction in this objectionable property.

Hardness in water for domestic use is objectionable for a number of reasons. Hard water fills the pores of the skin, prevents thorough cleansing and causes the hands to chap. A greater amount of soap and washing powder is necessary for washing. In the laundry, moreover, the calcium and magnesium soap compounds settle on the clothes and injure the material, and tend to cause the use of soaps or washing compounds containing ingredients destructive of the fabrics. Unsightly scums are formed in wash bowls and bathtubs, and incrustations on the interior of tea kettles and on the water-backs of kitchen stoves, interfering with the proper operation of water heating.

Hardness in water used for manufacturing purposes seriously affects the results. The objection may be one of expense or it may be vital to the entire process. A soft water is essential in the various processes of bleaching, dyeing, tanning, sugar-refining, paper-making, soap manufacture, brewing and distilling, etc.

Hard water is objectionable for steaming purposes on account of the scale which invariably forms on the sheets and in the tubes of boilers where it is used. The carbonates precipitate in the form of a soft mud which can easily be blown out. The sulphates of magnesium and calcium, however, form a hard crystalline scale, known as "porcelain scale," which is very difficult to remove. This scale absorbs heat, adds to the cost of attendance and repairs, shortens the life of the boiler, and dangerously increases the liability of explosion.

PLATE 88

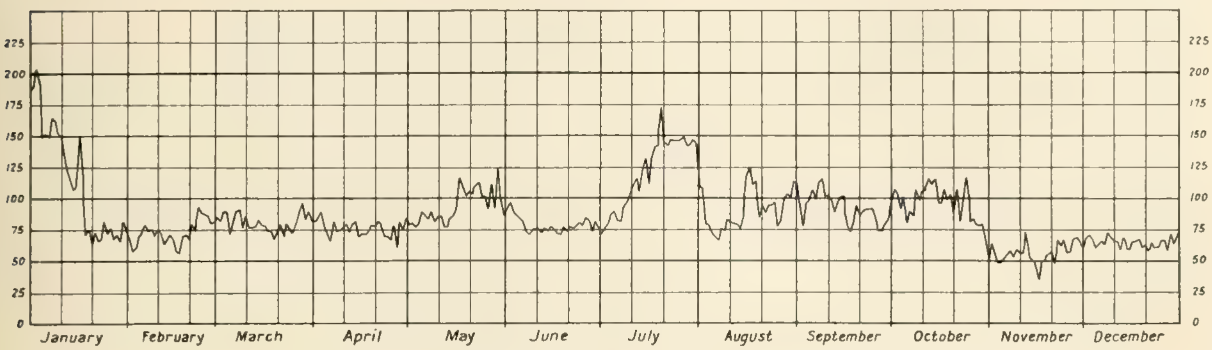


Hardness of Allegheny River at Aspinwall, 1909.

Allegheny River.

Plate 88 shows the daily hardness of the Allegheny River at Aspinwall for 1909, together with the estimated daily discharge. If the Seventeen Selected Projects were constructed, and the thirteen of these reservoirs that are located on the Allegheny Basin were half full at the beginning of the summer, the discharge of the Allegheny at Pittsburgh, in a year similar to 1909, could be maintained constantly at 4000 second-feet or four times the minimum, for the 137 days that it fell below that amount between July 12 and December 14. With this increase in the low-water flow, the average hardness, which during this period was 91 parts per million, would probably not exceed 65 parts per million. This would be equivalent to an average reduction in hardness during these 137 days of 26 parts per million.

PLATE 89



Hardness of Monongahela River at McKeesport, 1909.

Monongahela River.

Plate 89 shows the hardness of the Monongahela River at McKeesport for 1909. There is no record of the daily discharge of the Monongahela during low water, but if the four of the Seventeen Selected Projects located on this basin were constructed and were half full at the beginning of summer, an additional flow of about 800 second-feet could be maintained for 124 days. This would have given a uniform flow, during the low-water period of 1909, of about four times the minimum discharge. The average hardness for the 123 days from July 1 to October 31, inclusive, was 100 parts per million. On account of the lack of knowledge of the low-water discharge of the Monongahela, it is not possible to make an accurate estimate of the amount of reduction in hardness due to dilution, but from an inspection of Plate 89, it seems probable that it would have been at least 30 parts per million, or 30 per cent.

SAVING IN SOAP.

Allegheny River.

The saving in soap that would have been effected by the above reduction in the hardness of the Allegheny in the district supplied with water by the City of Pittsburgh may be estimated as follows: For every increase of one part per million of hardness, the cost of soap increases about $10 per million gallons of water completely softened. There is probably no city in the world where there is a larger amount of water per capita softened with soap, and it is considered that 10 gallons per capita per day thus softened is a conservative estimate. On this basis, 5,000,000 gallons per day are used with soap by the 500,000 population supplied with water by the City of Pittsburgh. As has been shown, the dilution of the Allegheny in 1909 would have reduced the average daily hardness 26 parts per million for 137 days. At $10 per million gallons for one part per million re-

duction in hardness, this would mean an average daily saving of $1,300, or a total for 137 days of $178,100.

In addition to the Pittsburgh supply, about 16,000,000 gallons daily are pumped from the Allegheny between Oil City and Pittsburgh, for domestic use. The increase in low-water flow by storage reservoirs would mean a daily saving in soap used in these communities of about $260, or a total for the low-water period of about $35,600.

This saving in soap would have been greater in 1908, when the discharge of the Allegheny at Pittsburgh was considerably less and the hardness very much greater; but daily records of the hardness are not available before the middle of September, and an estimate cannot be made. Some idea of the comparative hardness during the low-water period of the two years may be formed from the records for October and November, which show an average hardness of 138 and 143 parts per million respectively for these months in 1908, as against 116.5 and 86.3 parts per million for the corresponding months in 1909.

Monongahela River.

On the Monongahela River, about 25,000,000 gallons per day are pumped from the river in Pennsylvania for domestic use, supplying a population of about 140,000. Estimating, as before, 10 gallons per capita per day to be softened with soap, and taking $10 as the cost of the soap necessary to reduce the hardness one part per million, the estimated average reduction in hardness of 30 parts per million to be obtained by the release of impounded flood water would cause a saving in soap of about $420 per day, or a total for 124 days of $52,080.

Ohio River.

On the Ohio River, in the 40 miles between Pittsburgh and the state line, about 9,000,000 gallons daily are pumped from the river for domestic supply, of which it is estimated 400,000 gallons are softened with soap. Figuring on the same basis as above, the saving in soap would amount to about $14,800. A similar saving would of course take place for a considerable distance further downstream, for most of the communities bordering the Ohio use river water, and at Wheeling, 90 miles below Pittsburgh, as has already been shown, the low-water flow in 1908 would have been increased to over three times the minimum by the proposed storage reservoirs.

Total Saving.

The total saving on the three rivers in this one item of soap cost would therefore amount to about $280,000 annually, representing, at 5 per cent, the interest on $5,600,000.

Other Rivers.

The same improvement in the quality of the water would be effected on the Kiskiminetas, below Saltsburg, on the Youghiogheny, below Confluence, and on the West Fork of the Monongahela, below Clarksburg. There is no water pumped for domestic use from the Kiskiminetas below Blairsville, but from the Youghiogheny below Confluence, about 14,000,000 gallons per day are pumped by water companies, about 5,000,000 gallons of which are used for domestic supply. As already shown, the low-water flow of the Youghiogheny, in 1908, would have been increased to nearly 10 times its actual minimum. On the West Fork, between Clarksburg and the mouth, a population of about 21,000 is supplied with raw river water, the daily pumpage for this purpose being about 3,000,000 gallons. It has previously been shown that, in 1908, the flow of the West Fork would have been increased to 9 times its minimum and over 3 times its average flow during the low-water season.

TREATMENT OF WATER FOR INDUSTRIAL USES.

The hardness of water used for industrial purposes is removed by treatment in water-softening plants, where enough soda ash is added to change the calcium and magnesium sulphates to carbonates. This treatment removes about 70 per cent of these sulphates, and the reaction continues after the water is in the boilers, giving, instead of the hard sulphate scale, a soft scale or sludge, consisting almost wholly of carbonates, which is easily blown or washed out. At some works, the water for steaming purposes is treated with a boiler compound which has the same purpose as a complete water-softening plant, but gives poorer results.

The initial cost of a water-softening plant depends principally upon its capacity, and, excluding accessory changes in pumping and piping systems, varies from $5,000, for a plant treating 100,000 gallons per day, to $18,000, for a plant treating 1,500,000 gallons per day. The principal item of operating expense is the cost of chemicals, which, for the river waters in the vicinity of Pittsburgh, varies from one cent per 1,000 gallons upward. Assuming that the cost is one cent per 1,000 gallons, the saving in chemicals is estimated as follows:

SAVING IN REAGENTS.

Monongahela River.

As previously estimated, the average daily hardness of the Monongahela water, during 124 days of the low-water period of 1909, could have been reduced 30 parts per million, or 30 per cent. As stated later in this chapter, the average acidity of the Monongahela during this period could probably have been reduced 50 per cent. Assuming it could have been reduced at least the same percentage as the hardness, it is evident that 30 per cent less of the reagents would be needed. About 480,000,000 gallons daily are pumped from the river for industrial purposes, of which it is estimated that 30,000,000 gallons are treated either in water-softening plants or with boiler compounds to fit it for steaming purposes. This reduction in hardness and acidity by dilution would, therefore, enable a saving of $100 per day, or a total of $12,400 for the 124 days.

Allegheny River.

It has also been demonstrated that the hardness of the Allegheny water in 1909 could have been reduced an average of 26 parts per million or 28.6 per cent daily for 137 days of the low-water season. About 17,000,000 gallons per day are pumped from this river for steaming purposes between Kittanning and Pittsburgh. Not all this water is treated, but if it all were softened, the reduction in hardness would represent a saving of about $6,654 for the 137 days.

Kiskiminetas River.

Along the Kiskiminetas, between Saltsburg and the mouth, about 15,000,000 gallons per day are pumped from the river for industrial purposes, of which about 1,400,000 gallons are treated. As already shown, the low-water flow of this stream would have been increased by storage to an amount six times its actual minimum for 137 days in 1908. It would be safe to say that this dilution would have effected at least a 50 per cent reduction in the amount of reagents needed for treating the water during this period; or, figuring on the basis of a cost of one cent per 1,000 gallons for reagents, would have enabled a saving of about $1,000 in the cost of water treatment.

Ohio River.

There are 53 manufacturing plants of importance along the banks of the Ohio between Pittsburgh and the state line, employing about 28,000 men. The principal source

of supply for industrial use is the Ohio River, from which about 49,000,000 gallons are pumped daily for manufacturing purposes, about 5,000,000 gallons of which are used for steaming purposes and treated in water-softening plants or with boiler compounds. The reduction in the cost of treating this water, due to dilution, would have amounted, in 1909, to about $2,000. This improvement would, of course, extend down the Ohio a considerable distance below Wheeling, where, as previously shown, there would be a large increase in the low-water flow.

Total Saving.

The total annual saving in the treatment of river water for industrial uses effected by dilution would therefore amount, on the three rivers, to about $22,000, or, at 5 per cent, the interest on $440,000. In building new water-softening plants, moreover, the investment necessary would be smaller because less water would have to be treated and there would be less hardness and acidity to remove.

REDUCTION OF ACIDITY BY DILUTION.

Both the Allegheny and Monongahela Rivers receive large amounts of coal mine drainage. There are about 450 coal mines on the Allegheny Basin and 560 on the Monongahela Basin, 150 of which are in West Virginia. In spite of the considerable amount of mine drainage emptying into the Allegheny, especially from the Kiskiminetas, the water of the main stream in its lower course has been practically always alkaline. This condition, however, will in all probability not continue much longer unless the dry-weather flow be augmented; even now the water is frequently acid during each year. The Monongahela River, on the other hand, owing to its smaller discharge, which is only about one-third that of the Allegheny at extreme low water, and on account of the greater coal mining development in its basin, is highly acid. This is well known to the river men, and water for steaming purposes on boats plying the Monongahela is frequently brought in flat boats from the Allegheny River.

The greatest contributor to the acidity of the Monongahela is the Youghiogheny, as is clearly shown by the following analysis:

Monongahela at Clairton.........0.45 grains SO_3 per U. S. gallon.
Youghiogheny at Versailles.......7.91 grains SO_3 per U. S. gallon.
Monongahela at McKeesport......2.03 grains SO_3 per U. S. gallon.

The principal objection to the acidity of the river water is its corrosive action on boilers. It also considerably shortens the life of exposed iron and steel parts on boats and on the locks of the navigation dams. Three-eighths inch plates have been eaten to a knife-edge in a year's time, and the advisability of going back to the use of wooden lock gates has been seriously considered. The accompanying photographs, recently taken, show the effect of this acid water on the exposed steel parts of the locks.

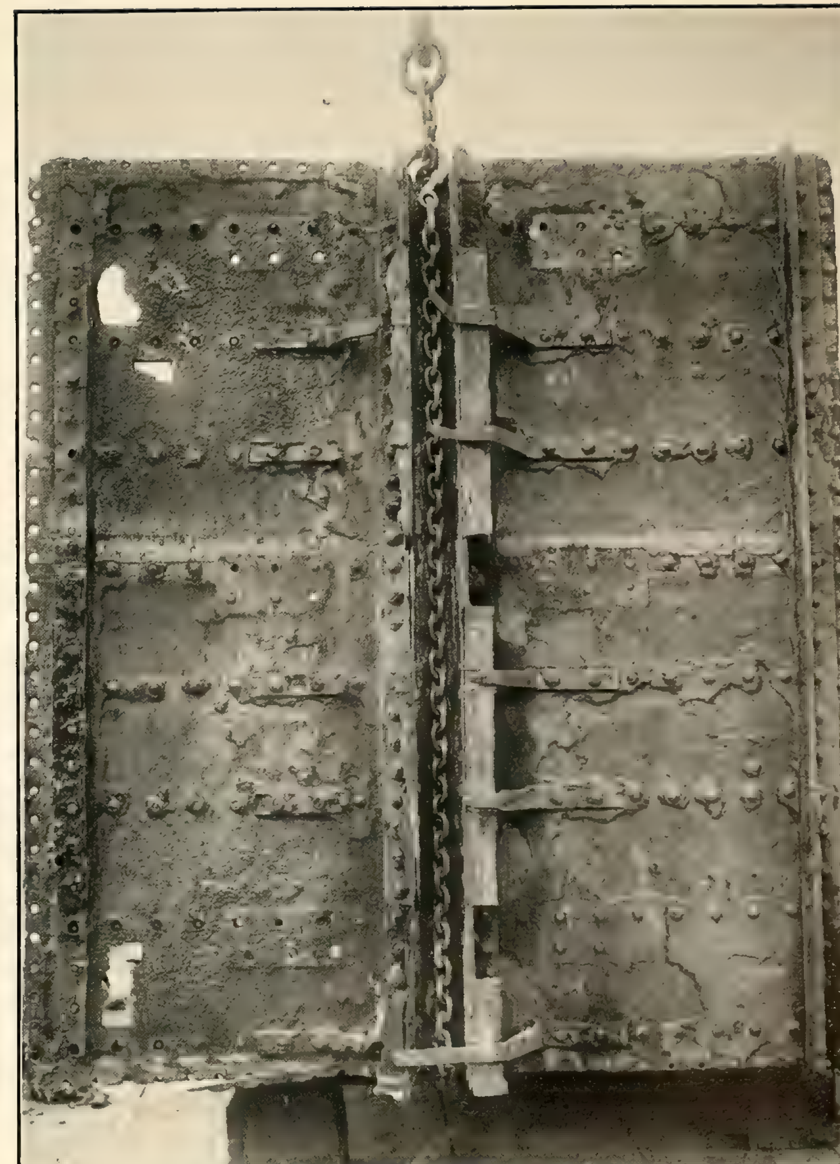
As an indication of the harmful action of such water, and as an example of other instances, the actual facts about which are not so readily obtainable, the following letter of March 25, 1911, to Mr. E. K. Morse, Chairman of the Engineering Committee, is quoted in full:

"Dear Sir:—

"In compliance with your oral request I have the honor to submit a brief statement of trouble that has been experienced at Lock 2, Monongahela River, on account of corrosion of steel lock gates.

"This lock is located a short distance below the mouth of Turtle Creek near the Edgar Thompson furnaces and rail mill. At this point the acid conditions are worse than at any of the other locks along the river. Repeated observations show that corrosion is most active in running water and hence is at its maximum along the edges of valves and bottom of lock gates, where there is leakage water under pressure passing with considerable velocity. Even a minute opening, as for instance that about a slightly loosened rivet, where there is any

Effect of Acid upon lower corner of steel lock gate, Lock No. 2, Monongahela River, thickness of plate ½ inch.



Effect of Acid upon steel filling valve, Lock No. 2, Monongahela River, thickness of plate ¾ inch.

pressure to force acid water thru it, appears to become a target for the most persistent attack of the acid, no accretion of rust being permitted to form as a protective coating. This probably accounts for the way in which one of the steel lock gates became so seriously damaged that it had to be removed. The gate was built in 1905 of nickel steel containing about 4 per cent of nickel. The miter and quoin posts and the horizontal frames were 20-inch I-beams of 65 pounds per linear foot, and the sheathing was of ⅜-inch plates. The bottom frame and the miter post were entirely eaten away at their connection for about a foot, and the rivets along one of the bottom flanges were entirely missing for 10 or 12 feet. About two years ago in repairing these gates it was deemed advisable to remove the old gusset plate at the lower end of the miter post and replace it with a new ⅜-inch plate. One of these new ⅜-inch plates for strengthening the corner of the gate was entirely consumed by the acid and on the other leaf of the gate only a remnant of the ⅜-inch plate was left. So greatly weakened had the gate become that the bottom I-beam on one gate showed signs of buckling under the pressure due to locking operations.

"There was but little damage to the gate a few feet above the bottom, and even at the bottom it was much less near the heel post, doubtless owing to the fact that but little leakage developed in that neighborhood. As to whether or not the nickel in the steel delayed the failure of the gate it is difficult to say. It might be averred that the total failure in two years of the ⅜-inch plates used for repairs argues in favor of the nickel having accomplished something. As against this, however, it must be remembered that the original plates, removed two years ago, were nickel steel and there was little left of them when taken out. The gusset plates were exposed to more violent currents than the other plates and that too on both sides. Authorities on the subject of nickel in steel as a preservative against corrosion of late appear to think that no decided improvement will be found with less than from 20 to 22 per cent of nickel in the compound.

Very respectfully,
H. C. Newcomer,
Lt. Col., Corps of Engineers."

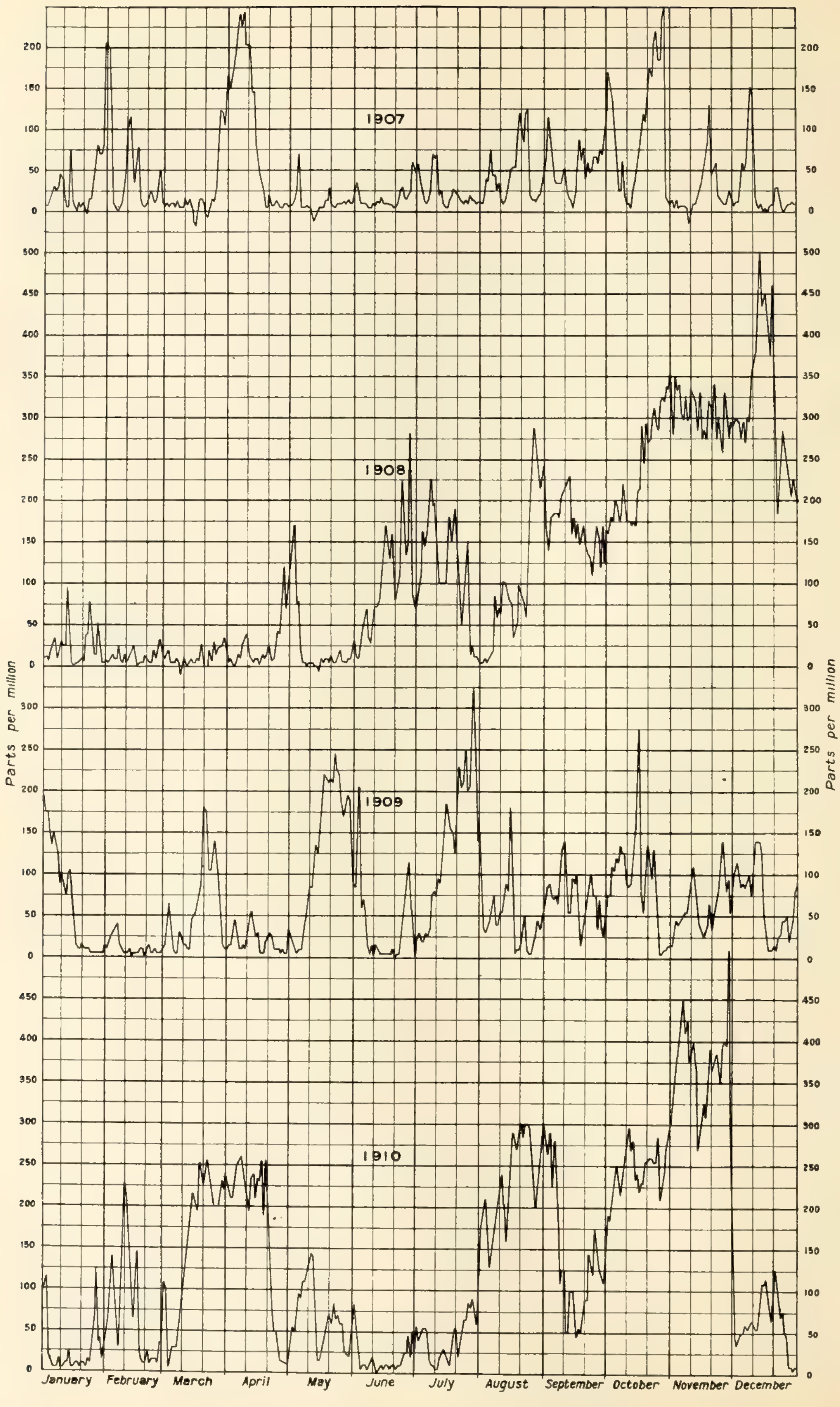
At no time of the year is the Monongahela water free from acidity and it is practically always treated before being used for steaming purposes. This treatment consists in adding enough milk of lime to neutralize the CO_2 and SO_3. During low water, the acidity becomes noticeably greater and shows a sudden increase at any rise in the river during this period, owing to the flushing out of the acid accumulated in the pools formed by the navigation dams. The amount of acid in the water is so variable that constant watchfulness must be employed in the operation of water-softening plants. Plate 90 shows the daily acidity of the Monongahela at Homestead for 1907-1910, inclusive.

As there is no record of the daily discharge of the Monongahela River during low water, the probable reduction in acidity that would be obtained by dilution cannot be determined as was the reduction in the hardness of the Allegheny. It seems reasonable to estimate, however, that during the 123 days from July 1 to October 31, 1909, inclusive, when, as has been shown, the increased discharge would have been four times the actual minimum, the average acidity of 18 parts per million would have been reduced 50 per cent.

PITTSBURGH FILTRATION SYSTEM.

The Pittsburgh Filtration Works are located at Aspinwall, on the right bank of the Allegheny River, 7 miles above the Point at Pittsburgh. They were built in 1905-1908, with 46 filter beds of one acre each, at a total cost, including land, of about $6,120,000; and the construction of 10 additional filters is now completed, at an additional cost, including land, of about $790,000.

The intake is located at Ross Station, about one mile above Dam No. 2, Allegheny, and seven miles above the Point, so that there is no possibility of any Monongahela water reaching the plant, and only the Allegheny water has to be treated. From this intake the water is pumped into three concrete-lined settling basins, having a combined capacity of 119,000,000 gallons, where it remains an average of something over 24 hours. From the sedimentation basins the water flows by gravity through the filter beds, which are of the covered slow-sand type, and thence into a covered clear-water reservoir of 50,000,000 gallons capacity. From there, still by gravity, the water flows through two 72-inch riveted-



Acidity of Monongahela River at Homestead.

steel mains, incased in concrete, across the Allegheny to the Brilliant Pumping Station, when it is lifted to the distributing reservoirs in Highland Park.

The action of a slow-sand filter depends upon the formation and preservation of the bacterial film, layer of dirt or filter medium at the surface of the sand, which retains bacteria and organic life and does not permit their passage through the sand bed. As this dirty layer becomes thicker the filtration head increases. When the loss of head reaches about five feet the filter is thrown out of service, the dirty layer scraped off and the filter again placed in use. At Aspinwall trouble has been experienced with a peculiar kind of clogging, which tends to decrease the length of run of a filter, but may at the same time increase the efficiency, by adding to the filter medium a sort of coagulated mat which settles on the surface of the sand.

The peculiar turbidity and cementing action of something in the water acting upon the filters has been for some time the subject of expert investigation at the Filtration Works. While the studies are not as yet sufficiently complete to permit a final report, they seem to indicate that the presence of some combination of iron salts has been the cause of the greater clogging. It is believed that the iron compounds change after the water has passed into the filters. The iron comes from the mines and culm banks, where the iron pyrites is dissolved and washed into the streams, and later is changed into one of the iron hydrates. This iron hydrate is, to a certain extent, deposited in the bed of the river, especially during low stages, and is stirred up and carried along by high water. It is evident, therefore, that very low water, on account of this deposition, and because of the fact that iron and acid conditions are more concentrated at that time, and high water, on account of its "stirring" action, both reduce the effectiveness of the filters.

On acount of the extensive mining developments within its watershed, the Kiskiminetas River is naturally the principal contributor of iron to the Allegheny water. Other streams entering the Allegheny in the stretch of 60 miles above Aspinwall also contribute acid at times. The principal offender on the Kiskiminetas, as shown by analyses made in August, 1909, by the Filtration Division of the Bureau of Water, is Loyalhanna Creek. Black Lick Creek, which also has many mines upon its drainage area, is another large contributor. The reservoirs proposed upon these two streams may largely remove the iron content of their waters, by settlement during long storage. But even if these waters should be but little improved by storage, the iron-impregnated flow from the Kiskiminetas drainage area, on reaching the Allegheny, would be very greatly diluted by the increased low-water flow of that stream, which would be practically free from iron, for very little of the remaining storage on the Allegheny Basin is on streams carrying large quantities of mine drainage.

It is not expected that the reduction of flood heights in the Allegheny by reservoir control will decrease the turbidity during the flood season to any appreciable extent. It is certain, however, that less suspended matter would be deposited in the channel if a uniform summer flow were maintained; while the amount of material stirred up and carried in suspension during the small summer and fall rises would be considerably less, owing to the equalization of the flow during this period.

Trouble with acid water has also been experienced in the operating efficiency of the filters. While acid has a sterilizing effect on the bacterial content of water, it is at the same time detrimental to the successful operation of sand filters, because it acts upon the filter mat, killing the bacterial life and destroying the *schmutzdecke* in places. The dissolving of the filter mat naturally decreases the loss of head, but also allows the finely divided particles of suspended matter to enter the body of the filter, and might, if carried

to a sufficient degree, cause what is termed "sub-surface clogging," *i. e.*—the closing of the interstices of the sand below the surface of the filter, which would necessitate the removal and cleaning of all sand to a depth below the line of clogging. With the increase of low-water flow and consequent dilution that would take place if the flood control reservoirs were built, all possibility of acid water would be removed.

If the low-water flow of the Allegheny were increased to several times its present amount, there would undoubtedly be a considerable saving in the cost of operating the Pittsburgh Filtration System. Under favorable conditions the average run of a filter at Pittsburgh is from 30 to 40 days, while under unfavorable conditions, it has been as low as from 15 to 17 days. It is not possible, with present experience, to estimate how much the run of a filter would be lengthened through the proposed improvement of the low-water flow, but it is obvious that the reduction in the number of cleanings per year would be considerable, and would lessen the total cost of maintenance.

BENEFITS OF REDUCED FLOOD STAGES.

With present conditions during floods the sewerage system of the city is unable to perform its duties, owing to the rivers backing up in the sewers. The reduction of flood heights by storage reservoirs would greatly reduce the area thus affected by backwater in the highest floods, while in ordinary floods there would be no backing-up. In any later plans that may be devised for improving the sewerage system, moreover, the reduction in flood heights would greatly simplify the design and considerably reduce the cost, especially if such plans should provide for transporting the sewage through main intercepting sewers.

CONCLUSION.

No estimate can be made, at this time, of the saving that the reduction in the flood stages would accomplish by the improvement of the conditions to which later designs for a comprehensive sewerage system must conform. As stated above, moreover, it has not been possible to arrive at any approximate figures representing the very considerable benefits of increased low-water flow to the Pittsburgh Filtration System. But even excluding these and similar benefits to other river communities, the total value of the improvement in the quality of the river water for domestic and industrial supply, due to the increased discharge during dry weather, would seem to warrant, as shown in the preceding pages, an expenditure of about $6,000,000 for reservoir construction.

CHAPTER XII.

RELATION OF STORAGE RESERVOIRS TO WATER POWER.

The investigations of the Flood Commission have not included a detailed study of the water power possibilities that would result from the construction of reservoirs proposed for flood prevention. The examination of the streams for the preparation of this report, however, disclosed the fact that there are a number of places, particularly in the drainage area of the Monongahela River, where steep slopes in the channels of the principal tributaries occur below the sites of some of the large storage reservoirs that are recommended. The natural conditions on certain streams are thus favorable, under well-planned combinations, for power development of considerable magnitude.

The effect of the manipulation of these reservoirs, if built, would be to increase the minimum flow. Surplus storage, which is also possible, in many instances, by enlargement of the flood control reservoirs, would further increase this minimum flow. With a definite flow of considerable amount thus assured, at any of these localities of steep channel slope, it would only be necessary to apply a method of obtaining the available head.

The Cheat, Youghiogheny and Tygart Valley Rivers offer favorable locations for water power development, above each of which storage capacity is feasible, amounting to a number of billions of cubic feet. On the Cheat, about 20 miles above the mouth, the fall in a distance of 10 miles amounts to 270 feet; and on the Youghiogheny, at Ohio Pyle, 60 miles above the mouth, there is a fall of 95 feet in a distance of 2 miles. About 28 miles from the mouth the Tygart Valley has a reach of 7 miles, which slopes at the rate of about 30 feet to the mile. The Clarion, tributary to the Allegheny, while not favored with steep slopes, presents, on the lower reaches, an example of water power possibilities from a group of well located reservoir sites of large capacity. Similar possibilities obtain upon some of the other principal tributaries.

In the aggregate many reservoir sites are feasible on the principal tributaries and on the branches, and these, under manipulation directed by state or national authority, could, in combination with the main projects, be made to effectively produce power and assist in the regulation of the navigable parts of the rivers.

APPENDIX.

APPENDIX NO. 1.

FOREST SERVICE,

UNITED STATES DEPARTMENT OF AGRICULTURE

HENRY S. GRAVES, Forester.

FOREST CONDITIONS ON THE ALLEGHENY AND MONONGAHELA BASINS

By

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Assistant Chief of State Cooperation,

O. D. INGALL,
Forest Agent, Forest Service,

and

RAPHAEL ZON,
Forest Service.

Accompanying forest map of these basins prepared by the Forest Service and the Pennsylvania Department of Forestry.

Base map by Flood Commission of Pittsburgh.

APPENDIX No. 1.

FOREST CONDITIONS ON THE ALLEGHENY AND MONONGAHELA BASINS.

Summary and Conclusions—Erosion and Run-off—Topography, Rocks and Soils—Forest Conditions—Forest Types and Humus Development—Relation of Cleared to Forest Areas—Reforestation—Conclusions—Description of the Drainage Basins — Forests and Stream-flow.

PART I—SUMMARY AND CONCLUSIONS

INTRODUCTION.

The Flood Commission of Pittsburgh was organized for the purpose of ascertaining the possibilities of conserving the flood waters of the Allegheny and Monongahela Rivers as a means of preventing the annual damage at Pittsburgh and elsewhere along these rivers, and of increasing the low-water flow.

In connection with the engineering work, which has included surveys of various drainage basins and the gauging of important streams, it was felt that a forest map of the entire watersheds showing the amount of forest cover and the general surface and forest conditions would aid the Commission materially in reaching conclusions relative to the flow of the different streams.

At the request of the Commission the Forest Service and the Pennsylvania Department of Forestry have prepared a forest map of the entire Allegheny and Monongahela watersheds.* The field work began in October and was completed the latter part of December, 1910.

In addition to the data obtained by the parties in the field, a large amount of information was obtained from the field maps of the U. S. Geological Survey for areas where more recent topographic sheets have been made. Acknowledgments are made to Mr. A. B. Brooks, Forester of the West Virginia Geological Survey, whose exhaustive studies of forest conditions in that State enabled him to furnish considerable information, and also to many lumbermen and surveyors, state and county officials and others who aided in the collection of data in the field.

This report is intended to accompany the forest map and explain in more or less detail the forest and surface conditions on the drainage areas of the various streams, which could not be graphically shown on the map. It was intended in the beginning to indicate on the map the condition of the humus on the forest land and its relative protective and absorptive capacity, as well as the location of all waste and barren areas. The collection of this information in detail was rendered impossible by the heavy fall of snow early in November, which remained on the ground throughout the remainder of the examination. Therefore, these features have been discussed only in a general way in the report. The relative humus forming capacities of the different forest types are explained in the chapter which discusses forest types.

In the absence of topographic sheets it was necessary to use enlarged county maps. These were mostly of very old date, although in one or two instances, as in Erie County, Pennsylvania, recent maps were available. Maps of the areas in New York not yet covered by the U. S. Geological Survey were kindly furnished by the State Highway Commission.

The forest data was placed on these maps in the field, and because of the large scale the work was done with considerable detail. Although quite a little of this detail has been lost in transferring to the map, which was made on a scale of 6 miles to 1 inch, the relative proportion of cleared and wooded areas is preserved, and the form and location of these areas are indicated as carefully as possible. Forests still unlumbered or practically in virgin condition are shown in heavy green. The prevailing types of forest are shown by letters.

The streams mentioned in this report are in general those whose names appear on the map. In several instances, however, streams are described, which, though shown on the map, are not named; and some streams, though shown and named on the map, are not described separately, because the forest conditions are not sufficiently distinct to merit it.

It is probable that fully two thirds of the wooded area, excepting the virgin spruce forests in

*This map will be found in pocket at back of book.

West Virginia, has burned one or more times. Light surface burns where the timber has not been killed or badly injured were not identified. Severe burns are shown by hatching.

It was the original purpose to show on the map the areas either cleared or in forest, which should be kept in forest permanently. This, however, was found to be inexpedient. The present wooded areas are largely on steep, rocky land, and the greater part of them should remain in forests either for purposes of protection, or, within agricultural and mining regions, for the local production of timber. Denuded and waste lands should be reforested.

FACTORS WHICH INFLUENCE EROSION AND RUN-OFF.

In the Northern States the action of water on the land surface and the flow of streams are essentially different from what they are farther south in the Piedmont Region. This is due to the more humid climate and shorter growing season in the North, which permit a greater humus development; to a much greater capacity for the formation of a grass cover over to soil; to the podous, rocky or sandy character of the soil itself, and the close underlying rock formations; and to the fact that a protective blanket of snow lies over the land for long periods when the precipitation is greatest. These conditions are found in the Allegheny and Monongahela watersheds. In the Piedmont Region, on the other hand, where deep, clay soils predominate, and conditions opposite to those of the North exist, the erosion and gullying effects of the run-off are manifest to a degree entirely impossible under northern conditions.

It should not be inferred that soil erosion does not exist on the drainage basins of the Allegheny and Monongahela. The wearing down of this plateau region and the cutting of deep gorges by the streams have been going on for ages. It is only when erosion becomes abnormal, as revealed by gullied fields and roadways and the washing away of stream banks, with excessive turbidity of the streams themselves, that man realizes its harmful effects and tries to remedy them. Such abnormal features do not exist to large extent in the watersheds under examination, and erosion, therefore, is not an important factor.

Other things being equal, the capacity of the soil to absorb the water which falls upon it determines the amount of erosion. Where the forest conditions are undisturbed and the humus or natural vegetable covering of the soil has not been burned, erosion is unnoticeable, and the streams run clear. Even where the forests have been extensively lumbered, and fires have burned periodically, there is little increase in the turbidity of the streams. This is the situation over the eastern tributaries of the Monongahela which flow from the forested areas and over most of the headwater streams forming the Allegheny River. These waters are clear to a marked degree.

The tributaries flowing from areas which are primarily agricultural are not so clear. In comparison with the streams which flow through the Piedmont, however, their turbidity is not marked. The clearing of land is the factor which makes soil erosion abnormal to the slight degree that it is in the interior basin region of the Allegheny and Monongahela watersheds. Examination has shown that gullying takes place occasionally on badly tilled land on steep slopes, and frequently along steep roadways. The banks of swiftly flowing streams often give way during seasons of freshets. Fields sometimes gully during excessive rainfalls, but afterwards become grass grown. Examples of excessive erosion are not frequent. In the most prosperous agricultural sections the slopes are often cleared to their summits, and steep rounded knobs are in the best of cultivation without any erosive effects. It rarely becomes necessary to terrace the slopes. Where the soil has washed in places, more rational systems of cultivation, such as deep plowing, increasing the humus content of the soil by alternating with forage crops, tile drainage, terracing on the steepest slopes, and the addition of lime to stiff clay soils, will remedy the difficulty. There is little land now in cultivation or in grass which cannot be maintained in a prosperous condition by proper farm management.

What has been said regarding the general absence of erosion does not indicate that the soils are capable of absorbing all the moisture that falls. The absence of serious erosive effects is attributable to a variety of factors, some of which have been mentioned briefly. The rapidity of the surface run-off, however, is much more pronounced, even though the soils are far more porous than the heavy, clay soils of the Piedmont. Limestone soils, when cleared, are susceptible to erosion and rapid run-off, although when covered with a humus layer in the forest, they are extremely absorbent. Shale soils on steep slopes give rise to rapid run-off, and when not in forest the erosion is considerable. The best of the shale soils, as well as the limestone, are in

cultivation, or, on the steeper slopes, in pasture. Shale disintegrates rapidly, and for this reason is not easily exhausted. Unfortunately, however, the humus covering is generally thin, and on cut-over or poorly wooded slopes where fires have been prevalent, the run-off of water is rapid, even though the thin and slaty character of the surface prevents appreciable erosion. The sandstone soils are on the mountain ranges and the high plateaus which form the headwaters of most of the tributary streams. Little of this class of soil is carried in the streams. The surface of the ground is usually covered with angular and massive rocks, and the underlying bed rocks are fissured or broken so that water absorption is satisfactory, if there is some vegetable matter in the soil.

In all classes of soil, a complete humus cover increases its porosity, and, on these watersheds at least, effectually prevents erosion. Since most of the remaining wooded areas are on steep slopes where the soil is shallow and less absorptive, and there is a greater tendency for the water to run off rapidly, the importance of a humus cover cannot be overestimated. Thick humus contains a high storage capacity even where the soil conditions and gradient are ordinarily unfavorable to water absorption. The accumulation of humus on forest soils undisturbed by fire or lumbering depends, of course, on the structure of the soil and the species forming the forest. A light, porous soil encourages rapid oxidation and decomposition of vegetable litter, and thin-crowned trees furnish less vegetable litter and permit more light and air to reach the ground. A heavy humus is not often found under these conditions, but rather where there is a dense crown cover, moderate exposure to air, and moisture in the soil.

The wooded areas remaining on these watersheds are in a large measure true forest lands Most of them are on steep, rocky slopes underlaid with formations of sandstone, which it is essential should remain wooded, while humus conditions should be improved. It is a recognized fact that of the tributaries of the Monongahela River, those which rise in the heavily wooded sections of the eastern divide are much more uniform in flow, have lower flood crests, and carry far less sediment than the upper Monongahela waters which drain an entirely agricultural section. In Pennsylvania, interesting comparisons have been made during periods of drought of the flow of streams through deforested and through well wooded sections. The streams through well wooded sections maintained a larger and more uniform flow.* The opinion of old residents in every part of these watersheds is that destructive lumbering and the burning of the humus covering of the soil have been the causes of the drying of springs and streams during summer droughts, and of the rapid rise and fall of water following heavy rainfalls or quick melting of snows in the winter or spring. On cleared lands, good humus conditions can generally be maintained by proper methods of farming. On forest lands, protection from fires is absolutely necessary to insure these conditions.

There are two classes of land on these watersheds which are a menace to the future prosperity of the region and which far-sighted citizens should seek to improve as long as there are any existing means for doing so. One of these is the waste land which occupies more than half the area about the great coal mining centers of Pennsylvania, east and south of Pittsburgh, including the lower drainage areas of the Monongahela and Youghiogheny, parts of the Conemaugh, and its headwaters in Cambria County, the Kiskiminetas and Loyalhanna, the headwaters of the Mahoning in southern Jefferson County, and parts of many other drainage areas where coal mining is now carried on or where the deposits have become exhausted and the lands abandoned. The other class of lands consists of the denuded and burned forest areas on the sandstone and conglomerate plateaus which cover the high elevations in the northeastern Allegheny headwaters centering about McKean County, Pennsylvania, and extending south along the divide. The same class of land is found to a less degree in the Laurel and Chestnut ridges, which extend from West Virginia north into Pennsylvania, and over large scattered areas on the Monongahela headwaters, especially in eastern Randolph County, West Virginia.

The waste mining areas are too poor for cultivation or even good pasture land, and natural reforestation can never be assured. They are mostly rocky and desolate, and covered at best with vines, weeds, and a scattered, scrubby growth of nearly worthless trees. The badly cut-over and burned forest lands bear stands of fire cherry, aspen and worthless oaks, with no humus covering the thin soil or naked rocks beneath. Not only are these two classes of land without present value, and in such condition that they add to the disastrous flood conditions of the streams by the rapidity of the run-off from them, but the conditions are constantly becoming worse. De-

*Annual Report of the Water Supply Commission of Pennsylvania, 1908.

teriorating, erosive influences are not apparent in a day or a year, but rapid run-off and the slow but increasing impoverishment of surface soil and humus, and the difficulty, if not impossibility, of the renewal of forest growth because of fires, continue, until in the future there will be no foundation upon which to rebuild and bring back their former productiveness.

After becoming saturated as a result of long-continued precipitation, these lands, even in their most prosperous condition, would not prevent disastrous floods in the lower streams. The tendency, however, would be to reduce the violence and frequency of the floods. In addition to this, all lands should be capable of producing something of value, and for the sake of future prosperity there should be a permanent forest and agricultural development. To bring this about, more intensive farming methods are needed for agricultural lands, and absolute protection from fire for non-agricultural lands. Waste lands cannot usually be brought back to forests without planting.

The progress of industrial development along the lower river courses, with the narrowing and clogging up of the channels by railroad embankments, fills, and construction material, will make it necessary to resort to artificial means of holding back flood waters in the tributary basins. The value of this artificial control and the work of protecting and developing the lower river courses may be rendered much more effective by the protection of the forests, the humus, and the soils at the headwaters.

GENERAL CHARACTER OF THE TOPOGRAPHY, ROCKS AND SOILS

The entire region drained by the Allegheny and Monongahela Rivers is a rolling and deeply dissected plateau, which slopes to the west from the escarpment or "face" of the Allegheny Mountains. The general features of a plateau are only interrupted by parallel mountain ranges which extend northeastward from West Virginia into western Maryland and Pennsylvania, where they decrease rapidly in elevation, become broader, and are finally obliterated in the Allegheny plateau. While the main divide between the Allegheny and the Susquehanna watersheds in central and northern Pennsylvania has all the features of a broad plateau, losing its mountainous character toward the north, the southern extension of this divide, between the Monongahela and the waters flowing into the Potomac and the Greenbrier, assumes mountainous characteristics, the highest elevations exceed 4,500 feet, and the topography is rough and steep. In western West Virginia, the topography of the divide is rolling, and the elevation does not exceed 1,800 feet.

Throughout the drainage basins the erosion of stream valleys and the peculiar feature of streams cutting their courses through parallel ridges have given a precipitous and even mountainous character to the topography. From the broad, elevated headwaters of the streams, however, the true plateau character of the topography is easily recognized.

The elevated plateau of the extreme north, including most of the northern tier of counties in western Pennsylvania, is capped with hard conglomerate or coarse sandstone. This plateau has been deeply dissected by many streams which have narrow, rough and stony valleys. Only the larger streams have bottom lands of any extent, and these are alluvial and derived from the shales underlying the hard top layers which the streams have exposed in cutting their valleys. The plateaus have, in general, sandy and rocky, infertile soils, classified under the DeKalb* series. The more fertile clays, which are derived from the lower shale rocks, and are classified as Upshur soils, are exposed where the sandstones and conglomerate layers have been removed.

Toward the basin of central western Pennsylvania, the elevations are lower and the rocks consist of a mixed series of shales, finer sandstone and limestone layers with coal beds. These finer-grained and less durable rocks have given rise to a gentler topography, generally with rounded hills and moderate slopes. The valleys of the streams, however, are still deeply cut below the general level of the high ridges, which form the minor divides of the streams. These ridges are usually capped with the same harder layers which are found farther north.

In southern Pennsylvania and West Virginia, the country, especially toward the east, where it is distinctly mountainous, is characterized by a series of wide valleys with moderate relief, and bounded by high, precipitous hills or ridges running northeast and southwest. As the eastern watershed is approached, the ridges are more numerous and the valleys narrower, culminating in a plateau country similar to that of the North. The soil is sandy and deeply covered with large rock fragments, though at the extreme south, the ridges are capped with limestone, and produce a

*The various soil designations in this report are those used by the U. S. Bureau of Soils.

fertile soil especially adapted to bluegrass. The elevations in this country are the highest of the two watersheds, reaching over 4,500 feet.

Limestone soils are on the whole more common in the Monongahela drainage than in the Allegheny, and give rise to clays and loams which are fertile but very liable to erosion on slopes. A noticeable and interesting phenonenom along the Monongahela are the many deposits of rich alluvial soils in old abandoned stream channels.

The western side of the Monongahela watershed, especially in its lower course, is a country of rich farm lands, while on the eastern side and at the headwaters of its large tributaries, the lands are mountainous and embrace a region which is suitable only for forest growth.

The northern and northwestern border of the Allegheny watershed has in comparatively recent geological times been influenced by glaciation. The glacial forces which changed the nature of the original soil also gave rise to very distinctive and characteristic forms of topography which contrast very strongly with the unglaciated country. The grinding of the great ice mass, and the various stream changes which occurred in glacial times, have smoothed off the original angular topography to one of gentle relief, with rounded hills, wide valleys and meandering streams, bordered by extensive bottom lands or intercepted by lakes. The soils are mainly an unstratified till of ground-up and reworked shales and sandstones of the native rock, mixed with the debris brought from the north by the ice sheet. Thus the Volusia soils, as they are called, are generally fine-textured silt loams, loams or clays. Boulders and worn rock fragments from foreign rocks are found throughout. The depth of the soils is variable. On high hills the glacial soils are often very thin, but old valleys have been sometimes filled to a great depth. The action of water in glacial and post-glacial times has also given rise to sorted and stratified alluvial soils. Thus sand and sandy loams or gravels occur in some valleys.

This glacial area, formed by the Wisconsin glacier, lies in a belt to the north and west of the Allegheny River. It runs in semicircular form away from the Pennsylvania-New York line above Warren and again crosses the line in the northeastern edge of the Allegheny watershed. The edge is marked by a terminal moraine with more stratified materials and typical morainal forms, such as kettles and valley trains.

To the immediate south and east of this belt lies a transitional zone, with only scattered glacial soils, and topography only slightly modified from the non-glaciated forms to the south. These soils are derived from finer sandstones and shales, and are spoken of in detailed reports as the Warren series.

The great non-glaciated region previously described lies to the south of this, and has a more angular topography, and soils derived from native rocks.

While alluvial bottom lands are absent along the narrow, swiftly-flowing, and eroding streams, they are quite general in the broader valleys, even at high elevations, and near the divides in glaciated territory at the north, where streams are sluggish and have not yet found their way to steeper slopes.

Deposits of bituminous coal underlie the greater part of these watersheds from the line of glaciation in the northern counties of Pennsylvania to the headwaters of the Monongahela and beyond, except portions of the eastern plateau and the parallel mountain ranges. The deposits north of Pittsburgh belong only to the lower formations, Monongahela, Conemaugh, Allegheny and Pottsville. In the south, the Greene County and Washington County formations are included, the lower measures being deep seated.

Gas and oil are found scattered in a belt running from Cattaraugus and Allegany counties, New York, southwest through Pennsylvania and the western counties of West Virginia.

FOREST CONDITIONS.

In no region of the United States have the natural forest conditions been more extensively modified by agricultural and industrial development than in the greater portion of these drainage areas. Throughout the central basin area, toward which the Allegheny and Monongahela Rivers converge, the soil was long ago found to be valuable for agriculture, and this was the first incentive to clear the land. This was followed shortly by the development of the coal mining industry. The fact that one-half or more of the coal supply of the country is located in this region is one of the most important causes of the present changed condition of the forests. As early as 1825, it is reported that 3,500 tons of coal were used in the vicinity of Pittsburgh. In 1846, the local consumption had increased to 46,400 tons. In the meantime agriculture had reached a high state of development and extended over the entire watersheds, except the mountainous headwaters of the Monongahela tribu-

taries, with the ridges extending north into Pennsylvania, and the rough sandstone plateau section in the eastern and northeastern portions of the Allegheny watershed. These remained almost in their virgin condition until later years. Agricultural development was accompanied by such an extensive clearing of land that even at that time many counties, such as Erie and Crawford in northwestern Pennsylvania, and Allegheny, Washington and Greene, farther south, contained few timbered areas except scattered and isolated woodlots.

The impetus given to forest destruction by the introduction of the iron industry and by the use of charcoal for fuel dates back to the early part of the century and went hand in hand with agricultural and grazing development. The oak and other hardwood forests of the western counties were consumed, and the best lands used for farms or pastures.

The lumber industry has been a separate and later development, and within the last sixty years has been of chief importance in sections north of the coal belt throughout the headwaters of the Allegheny. Previous to this time only the white pine in the river valleys was cut extensively. Subsequently the hemlock, which, with pine, was the important species, was cut for bark. The early history of the tan bark industry of Pennsylvania was one of reckless exploitation and waste. Saw mills were established as soon as the pine, hemlock and hardwoods away from the main valleys became marketable. At the present time, the lumber industry in the Allegheny headwaters is rapidly disappearing, and only a few small areas in two or three counties contain any of the original pine or hemlock. The great areas of forest land are now stripped and abandoned, except for the final cutting of mine timbers, ties, pulp and extract wood from the inferior hardwoods that were left. No other feature of present logging begins to be so disastrous as the cutting of small hardwoods for chemical plants, without any provision for fire protection and reforestation.

Many of the larger lumber companies, after completing their operations on the Allegheny headwaters, moved to the Monongahela headwaters in West Virginia and Maryland. The inaccessibility of the timber, and the difficulty of logging in the mountains forming the divide of the Monongahela, has left this section the last in the entire watershed to be exploited. The Youghiogheny headwaters in Maryland are almost completely cut over, and the remaining bodies of virgin timber are on the Cheat and some of its tributaries, and at the headwaters of Tygart River. There are said to be eighteen band sawmills now in operation in or adjacent to Randolph County, West Virginia. If this is true, then the lumber industry is probably at the height of its development, and the next ten years will doubtless witness the abandonment of most of these mills.

Spruce, hemlock and yellow poplar are the most important species now being logged in the virgin forests of West Virginia. On land formerly logged, small mills are cutting oak and all other species for a variety of uses, and immense quantities of mine timbers are shipped to the Pennsylvania mines. Yellow poplar is shipped to pulp mills in West Virginia and outside the State.

Throughout these watersheds the use of firewood is limited, because of the abundance of coal, oil and gas. Natural gas is cheap and used almost exclusively for fuel and light in most of the towns and even on many of the farms. The disastrous cutting of wood for charcoal, which was responsible for a large part of the earlier forest destruction in the mining region, has been largely eliminated within recent years. Woodlot conditions, however, have not improved generally, because of the demand for mine timbers, fence posts, ties and poles. In some purely agricultural sections, like parts of Clarion and Indiana counties, the woodlots are in good condition. This is also true of counties partly or wholly inside the region of glacial drift, where 90 per cent or over of the land is cleared and in farms or pastures. In still other woodlot sections, as in the western counties of West Virginia and parts of Pennsylvania, where stock raising has been an important industry, but is now diminishing, large areas of pasture are being reclaimed by forest growth and will in time become valuable woodlots. The restocking of abandoned pasture lands, however, is far from being the noticeable feature that it is in the Piedmont region of the South and in the more eastern states, where pine reproduces naturally and abundantly. Even in the best pine region of the northern counties of Pennsylvania, second-growth stands of pine are not frequent, and where found are badly injured by the weevil.

The steep, rocky slopes of the streams and rivers, which are characteristic of these watersheds, are nearly always found in forest growth, even where all other areas are cleared. This has an important influence in holding the banks from more rapid erosion, and such areas should always remain in forest.

FOREST TYPES AND THEIR RELATION TO HUMUS DEVELOPMENT.

As already stated under "Factors Which Influence Erosion and Run-off," the accumulation of

humus on forest soils undisturbed by fires or lumbering depends in a large measure upon the species forming the forest and the character of the forest types. The original forest types found on these watersheds have been greatly obscured or obliterated by lumbering and fires, and by the changes in soil and moisture conditions due to these agencies and to the mining industry. The change from one type to another is so rapid that close distinctions cannot be made over extensive areas. The types are, however, quite prominent on small areas. On the accompanying map an effort has been made to indicate by letters the types which are dominant over extensive areas. The most conspicuous of these are the following:

(1) Mixed oaks and chestnut.................................... Q.
(2) Hemlock and hardwoods.................................... H.
(3) White pine.................................... W. P.
(4) Beech, birch, maple and basswood.................................... B. B.
(5) Spruce .... S.
(6) Brush .... Br.

Mixed Oaks and Chestnut. This forest type mainly occupies the slopes and ridges on the dry, thin soils derived from sandstone and shales. In Pennsylvania, it is found at all elevations to the high lands bordering the Susquehanna divide, where it is confined to warm southern aspects. On north slopes, at higher elevations, it gives way to mixed hardwoods and hemlock, or chestnut mixed with these species, though with the oaks largely absent. In the Monongahela watershed this type occurs similarly, giving way to the beech, birch, maple and basswood type at about 2,500 feet or over, or to mixed hardwoods with yellow poplar or moist limestone soils. It is most abundant on dry southern exposures on the slopes of stream throughout the watersheds, and on the lower slopes of the parallel ranges in southern Pennsylvania and in West Virginia. In the Allegheny River valley in New York and northern Pennsylvania it is the prevailing type. It is also the prevailing type on the drier soils of the woodlot regions, often changing to nearly pure stands of oak, typical of the southwestern counties of Pennsylvania, or to stands where chestnut is nearly pure in groups.

Various species of oak comprise the type. On the lower, richer soils, white oak predominates. Red oak is common in the mixture, and chestnut oak, while much less common in the northern Allegheny tributaries, increases in abundance toward the south. Pitch pine occasionally occurs with the oak on thin sandy soils on exposed slopes at the higher elevations in northern Pennsylvania and in West Virginia. On the better soils of the woodlot regions, hickory, ash, maple, beech and other hardwoods displace or at least obscure the character of the oak and chestnut type. Where fires have been severe enough to kill out the chestnut, fire cherry and aspen are occasionally found mixed with the type.

The humus conditions on the slopes where this type predominates are usually poor, due to the thin foliage and rapid decomposition of vegetable matter. Repeated fires are prevalent, and cause the soil to become hard and baked, destroying its porosity and leading to a rapid run-off of the water.

Hemlock and Hardwoods. The hemlock and hardwoods type in general occupies the moist northern exposures of the valley slopes and mountain ranges and the deep cool ravines and hollows. While often common on deep, moist soils, it is largely confined to the steep, rocky slopes, both at high elevations and adjacent to the streams. Beech, birch and maple are the common hardwood associates, but the hemlock is sometimes pure. Often the hardwoods are the principal species, with hemlock as an understory or as scattered mature trees. This condition is especially true where former lumbering operations have changed the original composition of the type. On the upper slopes and drier sites white pine is sometimes found with the hemlock, in place of the usual hardwoods. Cherry, ash and basswood also occur in this mixture. The type is common throughout the two watersheds, and occupies extensive areas on the slopes bordering the Allegheny and along such streams as the Clarion, Red Bank and Tionesta in the north, and the Cheat in West Virginia. At higher elevations it is abundant on the colder slopes of the mountains.

The humus is usually moist and deep, and the continuation of the type depends more on a favorable humus than upon the character of the soil beneath. Fires are less common than in the oak and chestnut type, and where the type prevails over large areas, it is significant of conditions favorable to water absorption and gradual seepage, rather than rapid run-off. After lumbering, the type is subject to severe fires, because of the great amount of very inflammable slash from the hemlock, and the large amounts of humus and duff which form the forest floor. It is generally succeeded by hardwoods; sometimes by areas of brush and waste, where fires have followed severe lumbering on thin, rocky soil.

White Pine. The white pine type in northern Pennsylvania formerly occupied the deep, porous, sandy loam soils of well-drained bottoms and slopes along the Allegheny River and as far as the heads of the various streams near the divides. It was also scattered in the valleys of the Monongahela tributaries in West Virginia. It was often pure over limited areas, and the trees grew to immense size. More often the type was associated with hemlock and the stand often exceeded 50,000 board feet per acre. The original stands have now almost entirely disappeared and there is little pine reproduction.

The best second-growth stands are now found in southern Venango, Clarion, Jefferson, Indiana, western Cambria and Armstrong counties, and in the valley between the mountain ranges in Somerset County. In the region of the Allegheny River, near the lower Clarion and Mahoning, some fine stands of young second-growth white pine have developed. In no part of the watersheds does the type form a conspicuous part of the forest growth; over the greater part of the watersheds it is entirely absent.

Under the pine type the humus is usually thin. On exposed, sandy slopes, where pitch pine or white pine are found in open stands, the humus may be almost entirely lacking. It is best under dense young stands of white pine on nearly level land.

Beech, Birch, Maple and Basswood. This type is most common at elevations above 2,000 to 2,500 feet, higher on exposed situations than on sheltered ones. In the Allegheny watershed it is found at the highest elevations on ridges and on the level or rolling plateaus of the tributary watersheds. It is there frequently mixed with hemlock, and sometimes with white pine and chestnut. It is the prevailing type over the barren sandstone and conglomerate areas at high elevations at the headwaters of the Allegheny in McKean, Elk, Forest and Potter counties and north of the Allegheny in New York. In the woodlots, especially, it may often be found as either pure beech or pure maple, or with beech forming an understory with the other hardwoods.

In West Virginia the type often forms a narrow belt on the mountain slopes above the elevations where oak is dominant, and below the spruce type. It is associated with yellow poplar at the heads of creeks on limestone soil, and commonly with hemlock. The largest amount of yellow poplar is found at the head of Valley River in Randolph and Pocahontas counties, and over the main divide in these counties. At its highest elevations it is found with spruce. Ash, cherry, locust and cucumber are sometimes found in the mixture.

This type has been extensively lumbered and badly burned, especially in northern Pennsylvania and New York. Where fires have burned repeatedly, the type gives way to fire cherry and aspen, which cover large areas either singly or together. These fire cherry areas are characteristic of immense stretches of country in central McKean and adjoining counties. The growth is thin and brushy, but its value as a soil cover is considerable.

Under normal conditions there is usually plenty of soil moisture, and the humus covering is much better than at lower elevations or on more exposed slopes where oak, chestnut and other species in mixture are commonly found.

Spruce. The spruce type occupies extensive areas at the headwaters of the Cheat and Tygart Rivers in Tucker, Randolph and Pocahontas counties, West Virginia, and is not found to any extent in any other part of the Monongahela watershed. It is entirely absent from the Allegheny watershed. While formerly much more widely distributed at high elevations in West Virginia, and at the head of the Youghiogheny, in Garrett County, Maryland, lumbering and fires have now so restricted the type that it is largely confined to the areas not yet logged above 3,000 to 3,500 feet elevation. It was formerly quite abundant between 2,500 and 3,000 feet.

Spruce flourishes where the soil and atmospheric moisture is abundant, and it has been able to compete at high elevations on thin, rocky soil with more exacting hardwood species. Thus it is found on steep mountain slopes, where a dense humus covers the rocks beneath, and in pure stands on the level, poorly-drained plateaus at the highest elevations. On the slopes it is mixed with hemlock, and to some extent with birch, beech, basswood and hard maple.

The area of the spruce type is being reduced each year by fires and logging operations. Before lumbering began extensively, large areas were burned, and the timber was killed on the high flats in order to furnish a summer range for cattle. Since then, logging followed by fires has transformed the type into brushy areas of aspen and cherry. Some of the steep slopes and thin rocky plateaus in eastern Randolph County are practically denuded, without tree growth of any description.

Fires on cut-over spruce land are the most serious that can occur. The humus is usually burned away to the bed rocks, so that there is little or no surface to absorb the heavy precipitation and to regenerate another forest growth of any commercial or even protective value. In virgin spruce forests the humus accumulates to greater depths than in any other type found on these watersheds.

The destruction of this humus by fire after lumbering leads to a rapid disappearance of the type itself.

Brush. In this report, brush lands represent areas where the growth has deteriorated to scrubby and nearly worthless species, such as fire cherry, aspen and scrub oak. These lands will not for many years, if ever, become naturally reforested with timber of commercial value. Young growth which consists of valuable species is classified under one of the other types.

The brush type covers areas formerly occupied by one of the previous types and now denuded because of lumbering and fires. The hemlock and hardwoods type, and the beech, birch, maple and basswood type often become denuded in this way. The spruce type is also subject to similar transformation.

The soil is generally thin and rocky, and without humus. The type is common in small areas throughout the watersheds, but covers extensive areas on poor sandstone soils in the northern Allegheny tributaries and on slopes along railroad lines through wooded sections where the timber has been exhausted for mine props and chemical wood. It is less abundant in the Monongahela headwaters, where cut-over lands are generally in better condition. Examples of this type on spruce lands are found at high elevations in eastern Randolph County, West Virginia.

RELATION OF CLEARED TO FOREST AREAS.

An examination of the accompanying map shows the extremely irregular distribution of the forested and cleared areas. These watersheds have been settled for many years, and the best agricultural lands have long been cleared and placed in cultivation or pasture. Extensive areas of forest land, therefore, indicate the presence of thin, rocky soils of so little agricultural value that through all the years of settlement and devolopment these lands have remained uncleared. They are found in compact bodies in the northeastern counties of the Allegheny watershed in Pennsylvania, and over the greater part of the eastern tributaries of the Monongahela in West Virginia, Maryland and southern Pennsylvania.

Away from these wooded regions the watersheds are largely cleared, and small woodlots prevail. Very little clearing of new land takes place. The woodlots occupy the least valuable soils, and there is no incentive to clear them. On the other hand, greater areas have been cleared than can now be properly managed under the more intensive systems of agriculture. Many farms have been abandoned within the last twenty-five or thirty years. Immense areas in scattered lots, formerly cleared for pasture or practically denuded through the development of coal mining, are now abandoned. These lands are in part at least reverting to forest growth, and it is probable that the amount of forest land within agricultural regions is increasing to some extent. Unfortunately, land which is thus thrown out of cultivation or pasture does not readily become reforested. In time, however, such species as locust, cherry, maple, and, to some extent in West Virginia, yellow poplar, become established, and mixed stands of hardwoods of low value develop. The present awakening to the possibility of greater future development of eastern farms and orchards, now following the western movement which has been in progress for the last thirty years, may result in the rejuvenation of many abandoned farms, and will undoubtedly lead to a more prosperous use of the lands in cultivation.

In the wooded regions, the clearing of new land is going on wherever the soils are susceptible to cultivation, so that certain portions of them are becoming more and more interrupted by clearings. This is true in sections of Clearfield, Jefferson, Indiana and Cambria counties, Pennsylvania, and in some sections of Upshur, Randolph, Tucker and Preston counties, West Virginia, and to a less degree in other counties largely wooded. The fact, however, that continuous wooded areas exist in sections close to centers of population is conclusive that either the character of the soil or the topography makes the land of poor agricultural value. The narrow bottomland valleys of the eastern Monongahela tributaries are already cleared, and aside from some rich limestone areas at high elevations, which will be cleared in the future, the total acreage of forest land is not likely to decrease to any great extent in the future. These forest lands are very largely confined to the sandstone and conglomerate ridges and plateaus or to steep, shale slopes along the streams where cultivation or pasturage would not be feasible. In general, while the clearing continues to some extent in forested regions, the great area of rough, wooded country represented by McKean, Warren, Forest and Elk counties in northern Pennsylvania, the Laurel and Chestnut ridges, and other ridges and high sandstone plateaus on the watersheds of the eastern tributaries of the Monongahela in southern Pennsylvania, West Virginia and Maryland will always remain in forest.

The problem of surface run-off in relation to the clearing of additional forest land is not of great importance. It is of far more importance that lands already cleared be placed under more

intensive systems of farm management if they are not to be reforested. Planting as a means of preserving the soil and increasing land values on cleared and abandoned areas will unquestionably be resorted to in the future. On forest lands protection from fire will generally bring about the same results.

REFORESTATION.

In the descriptions of the various watersheds, mention has been made of the large areas of totally waste land which are unsuited for agriculture and which possess little or no woody cover. It has also been pointed out that in the agricultural sections there is more cleared land than can be managed under more intensive methods of farming. As a means of checking rapid run-off of water and helping to prevent damaging flood conditions in the valleys, at least supplementary to the artificial methods of stream control proposed by the engineers, all these waste and unused areas should be reforested. Where there is already some tree growth, it should be fostered as a nucleus of a new stand, and properly managed and protected. Even if of inferior species, or in bad condition from abuse, it will act as a protective cover and a nurse crop. Planting under such circumstances will be confined to an effort to improve the crown cover by filling open places, or to underplanting with a more valuable species.

Three things should be recognized at the outset in discussing plantations. First, it is useless to plant an area unless absolute protection from fire can be guaranteed. Second, planting is an expensive undertaking and the actual cash returns are not great when expressed as an interest rate on the investment. Third, planting should not be done in a haphazard manner. It requires a close study of the situation and expert management. For these reasons extensive planting is more likely to succeed if it is done by a community acting as a unit, such as a town, county or state, or by the large mine and timber owners. The community can exercise police powers for protection, can afford to make a long-time investment at a low rate of interest, employ expert advice, and give proper management over a long period of time. Besides this the community takes into consideration the factor of public welfare, both present and future, which enters so largely into a problem of this nature, but of which the individual, unless purely philanthropic, loses sight.

Portions of the waste lands in Potter, McKean, Forest, Elk and Warren counties should be replanted, as well as the great areas around the coal mining districts where the forests have disappeared through very severe cutting and fire. The lands immediately around the coke ovens, however, are unsuitable because of the noxious gases. The vicinity of a mining country is, on a whole, very favorable to planting, since there is always a constant market for small and rough products such as ties and mine props, which can be supplied by small and relatively young trees. A market for small products is thus a big factor in making intensive forestry a financial success. Planting in good agricultural regions for small local supplies on the farms is also recommended, and can be done on an intensive basis. Many of the farm woodlots which are in poor condition, too open or growing up to inferior trees, could be improved by judicious planting.

The trees planted should, as a rule, be species native to the district. Exotics may be very successful, but they should always be planted at first in the way of experiment. Some of the native species, however, are subject to insect or fungi attacks and should not be selected. Thus it can readily be seen that planting requires a close study of individual conditions, and detailed recommendations can only be made for special localities.

The large areas of rough land in the north will need to be planted in a way which will take into consideration the value of the forest for protection and the production of timber suitable for lumber on a long rotation. In the coal mining regions, the excellent demand for mine prop timber will allow of more intensive methods and a crop of quick-growing trees on a short rotation. It would be well also to plan to raise at the same time a crop of more enduring trees on a long rotation, both for soil protection and in order that the forest may produce large timber when the local coal supply is exhausted. In this coal region, much of the land has been unsuited for agriculture on account of the sinking in of coal mines. During this process the moisture content of the soil has been very much modified. The increased underground drainage has improved the condition of some of the heavier soils, but has caused the lighter soils to become dry. Therefore, the former growth on these lands is not a safe guide as to what to plant.

This whole subject has been more fully discussed and suggestions given in Circular No. 41* of the Forest Service. The results obtained by the company mentioned in the circular have been very fair. Of the species recommended, the larch, maple and yellow poplar have not been a success. In

*Forest Planting on Coal Lands in Western Pennsylvania.

the absence of a detailed examination it is impossible to say what have been the causes for the failures. Catalpa has made the best growth, but while it is a rapid grower in youth it requires a good soil for success and its uses are very restricted.

Osage orange has in one or two cases been planted in southwestern Pennsylvania to prevent the gullying of banks, but without great success. Locust is coming up naturally on some old fields in the central and southern part of the region. It would be an excellent tree for planting, on account of its fast growth and capability of increasing soil fertility, were it not for the serious insect ravages to which it is almost universally subject. White pine is also subject to insect and fungus attacks and its desirability for these reasons is somewhat questionable. Red oak, red pine, Scotch pine, shortleaf pine and Norway spruce have been suggested as suitable species, but they are as yet untried in the region. On the very badly wasted land, broadcast seeding of aspen or possibly ailanthus should establish a cover crop of wood that could be utilized for pulpwood. This crop would help to prepare the ground in suitable condition, and might later be underplanted with a shade enduring conifer. All native hardwoods would undoubtedly succeed on suitable soils, but before starting any extensive replanting operation, a series of experimental plantings should be undertaken.

Where there are large waste areas that are in very poor condition, as in the north, the planting should be on a scale of at least from 500 to 1,000 acres as a unit, so that the cost of both planting and protection per acre would be reduced to a minimum. The large amount of debris, dead and down timber, stumps and tops, will be a hindrance to planting, but if large areas are handled, there is a possibility that the disposal of much of this material for chemical wood, mine timbers, and such products, would help to pay for the clearing up of the ground. Fire lines would be a necessity, and patrols would probably have to be maintained in dry weather. Good roads not only serve the purpose of checking fires, but would be generally useful and a permanent improvement to the country.

All these suggestions are merely tentative, as there has not been enough experimental work done as yet to warrant any very specific recommendations, and a detailed study of the subject is hardly within the scope of this report.

CONCLUSIONS.

No attempt has been made to draw final conclusions regarding the flow of streams in relation to the humus and forest conditions. The purpose in presenting this map and the report accompanying it is to show as far as could be ascertained in the time devoted to the work the conditions that actually exist on these watersheds. There are, however, a number of conclusions in regard to the general surface conditions on the watersheds, which stand out rather prominently. They are as follows:

There is a constant deterioration of the soil, humus and forest growth.

Erosion seems to be confined almost entirely to cleared land which has been abandoned or is in poor cultivation, in the lower courses of the Allegheny, the Youghiogheny, and the Monongahela Rivers. The streams are noticeably clear, except during freshets, and then the turbidity occurs largely in the lower courses.

Surface run-off is extremely rapid, due to the prevailing steep slopes, and to the lack of good humus conditions and the open character of the forest growth, the result of frequent fires.

The greater part of the remaining forested areas are on steep, rocky slopes, most of which are too poor to cultivate. Virgin forests are now confined to small isolated patches in the Allegheny watershed and to some of the eastern tributaries of the Monongahela River. Second-growth forests are generally inferior in quality, and the more valuable species, which include the conifers, are conspicuously absent. Cutting for mine props, pulp and chemical wood, since logging operations ceased, has stripped most of the growth from the larger forest areas of the Allegheny watershed.

The clearing of land is still taking place to some extent within the heavily forested sections. In the agricultural regions there are few new clearings made and there is a tendency for some cleared and abandoned lands to revert to forest. Cleared lands which are abandoned and lying waste, and cannot become reforested naturally, should be planted.

The great needs of the region are an increase in the humus covering of both agricultural and forest soils, and an increase in the density of the forest, in order to lessen the rapidity of the surface run-off. The only practicable way to bring about these conditions is to protect the forest lands from fire, and to maintain agricultural lands in a high state of cultivation.

PART II—DETAILED DESCRIPTIONS OF THE DRAINAGE BASINS.

ALLEGHENY BASIN.

DRAINAGE OF THE HEADWATERS.

The source of the Allegheny River is in the central part of Potter County, Pennsylvania. Oswego and Potato creeks are the principal tributaries, and with the main stream drain the territory which comprises western Potter and eastern McKean counties, Pennsylvania, and southwestern Allegany County, New York. The country thus drained is a high, deeply-dissected plateou, which gives it the appearance of being mountainous, and it is so called locally.

The principal streams flow through moderately wide valleys, ranging from one-quarter to one mile in width, with fair amounts of bottom land. The slopes of these valleys are, however, very steep and rugged. The tributary streams cut narrow, gorge-like valleys, and flow swiftly, with short, steep grades and rocky beds.

While the extreme north and east of this region lie within the Volusia soil series of the Wisconsin glacial area, the greater part is covered with the infertile soils of the DeKalb series. Only in the main valleys are the soils deep and fertile and to any extent cultivated. Oswego Creek has quite a large deposit of outwash from the glacial region at its head. The ridge soils are generally sandy or rocky. In many places the higher ridges and steep slopes are covered with immense rocky fragments of coarse conglomerate, in one place being piled in such large quantities and such fantastic manner as to merit the name of Rock City and to be exploited as the show place of the vicinity.

Owing to the flat character of the bottoms and the clayey nature of these soils, the run-off is often sluggish and swampy, and "sour" spots are the result. These are often covered with dense stands of young hemlock. The stream-flow is very irregular, frequently flooding the larger valleys in the spring, and in times of drought sinking to a point where the smaller streams become dry. Old residents claim that this variation in run-off is now much greater than formerly. No gullying or washing of the hills is noticeable, but the alluvial flats, silt and sand bars in the larger streams are indicative of a certain amount of erosion and changes of stream channels within their flood plains. Trees along the banks frequently have their roots undermined and exposed by spring freshets.

The country is well wooded, about 90 per cent being covered with some kind of forest growth. North into New York State the cleared areas become larger as the land becomes less rugged and the topography more rounded, until at the northern divide the forest assumes a woodlot condition. This northern land is largely given up to grazing, and both hills and valleys are cleared, while in Pennsylvania the principal areas of farm land are in the valleys, although there are considerable areas of cleared upland where the more extensive plateaus occur.

Farming is not carried on intensively except in the valleys and toward the north. Many farmers seem content merely to make a living in the hope of finally striking oil or gas on their lands. In some cases where wells have become productive the farms have been abandoned. Probably 50 per cent of the valley areas are in grass.

In the north, farming has been carried on longer and more extensively than in the south, and almost all land suitable for agriculture has already been cleared, though attempts are still being made to clear land for grazing. Much absolute forest land has been cleared and is now reverting to woody growth. In Pennsylvania so much of the land is unsuitable for farm purposes that the per cent of cleared land will increase but slowly. On the other hand, much land which is now waste through fires and heavy cutting for lumber and chemical wood will revert to forest under better protection. It is likely that clearings and reversion will keep the ratio of cleared land and forest land about in its present proportion. The retention of mineral rights will also act as a deterrent to clearing.

This region was formerly rich in hemlock and white pine, but the remaining stands are now largely second-growth hardwoods, with scattered hemlocks and small bunches of white pine, the latter especially in old fields. There is some virgin white pine and hemlock with a little oak and maple at the head of Potato Creek. While in the Allegheny slopes and the lower reaches of its larger tributaries run to oak and chestnut to a great extent, the main portion of the stands is of the beech, birch and maple type. The plateaus were originally all of this type, and the second growth is of the same species, except where the action of devastating fires has made way for fire cherry and aspen. An understory of hemlock and beech is occasionally found in certain stands, and improves the density and humus conditions immensely.

The results of fifty years of lumbering and subsequent neglect have made many parts of the

After a Heavy Cutting in Dense Hemlock and Hardwoods Type.
Such cuttings are usually followed by destructive fires.

Hemlock and Hardwoods Type After Severe Lumbering and Fires
In Northern Pennsylvania.

area a total waste, and have left on other parts nothing but an open stand of very inferior and injured trees. On such sites the humus is largely absent or very thin. All other conditions being equal, humus is best under the virgin stands of conifers, good under beech, birch and maple in the coves, fair under the oak and chestnut type, and poor under aspen and fire cherry. Of late years the constant culling for merchantable material, such as ties and poles, has been succeeded by clean cutting for paper and chemical wood, and large areas are entirely denuded.

Fires have burned the greater part of the area from time to time, though in the farm sections the fires are generally well confined to areas intended for pasture. In the bigger stretches of rough land fires are likely to be set at any time and run unchecked until they burn out.

DRAINAGE IN CATTARAUGUS COUNTY, NEW YORK.

From the standpoint of topography and forest classification, this region may be divided into two parts—the northern section of rolling topography forming the divide of the county, and the southern section of very rough topography. The former is largely agricultural, while the latter is largely forest land with only a small proportion in cultivation. The latter division is a part of the same rough plateau section described near the headwaters of the Allegheny.

In the northern portion, the land is a rolling plateau with smooth, rounded hills, few or no rock outcrops, with valleys with steep to moderate slopes, flat stream divides, and extensive stream bottom lands, sometimes with small lakes intervening. It represents a section influenced by glaciation. As the valleys approach the rougher land to the south, they become narrower, deeper, and with steeper valley sides. The greater part of this land is cleared and has become a rich agricultural section with scattered woodlots. About 75 to 80 per cent of the cleared land is in grass and very little of it is waste land. While the rapidity of the run-off is probably increased by the large proportion of cleared land, no perceptible indications of erosure are apparent. The presence of strips of woodland on upper slopes may help to retard run-off. The soil is fairly deep and fertile and the farms are mainly devoted to dairying, though good fruit orchards are occasionally seen. Most of the farms are very prosperous and land values are high.

The woodlots are generally scattered strips along and just under the brows of the hills, at the heads of the narrower valleys and on the swampy areas in the bottom lands. The upland type is mainly beech and maple, with some oak, birch, butternut, hickory, basswood and ash. In the bottoms, maple, ash, elm and hemlock predominate. White pine is found occasionally. Most of the woodlots are of second-growth and in thrifty condition. The humus is, on the whole, very good and fires are uncommon. Some small areas, especially toward the south and in the bottoms, are being cleared, but the per cent of forest land is about stationary and is likely to remain so. No lumbering operations are taking place, and the farmers only cut from time to time as the needs of the farm dictate. Many of the lots are being overcut and on these the practice of woodlot forestry is desirable.

The southern portion of the region extends north of the Allegheny River for about two to eight miles. The topography is very rough; the valleys are narrow, with very steep slopes; and the ridges between are steep and narrow. The soil is thin, largely infertile and full of rock fragments. The proportion of wooded and denuded land is very high, and the small cleared areas are largely in grass and brushy pastures. No erosion is noticeable, though the clearing and burning of these steep, thin-soiled slopes have reduced the retentive power of the soil and increased the rapidity of run-off. The larger part of this area is absolute forest land, and valuable only for timber and protective purposes.

The farms are confined to the narrow bottom lands and to areas partially cleared for pasturage on the steep slopes and ridgetops. The only soils well suited for crops are the alluvial deposits in the lower reaches of the valleys and along the Allegheny River. The bottom lands of the Allegheny and the lower courses of the principal tributaries are mostly cleared, although there are extensive wooded and waste areas within these bottoms where the soil is poorly drained. Hemlock and patches of oak form the principal forest growth. It is not uncommon to find the wooded areas extending from the bordering slopes to the banks of the river. The farms are largely owned by Indians, who were placed in reservations along the river.

South of the Allegheny valley, toward the Pennsylvania line, the cleared areas become fewer and smaller along the minor streams, and rarely extend more than a few miles from the main valley. Between these narrow valleys the region is uniformly wooded. Tuneungwant Creek has a wider valley and a larger amount of cleared land than the creeks flowing from the south. North of the Allegheny the main forested belt runs up the steep hillsides between the larger valleys, and finally gives way to the northern agricultural region. Heavy cutting for lumber, pulp and chemical wood, followed

by frequent fires, has impoverished the originally thin and infertile soil. On the main valley sides, scrubby oaks, hickory, ironwood, birch and maple are the characteristic species. The badly burned areas are frequently covered with aspen and cherry.

Farther back from the valleys, and on the uplands, there is found the regular beech, birch and maple type, with some scattered hemlock. This land is mostly covered with a fair second-growth of hardwoods, with scattered cull trees of original growth. The density is variable, and many areas have been partially cleared by fire and the axe for pasture. On the whole, fires have been prevalent and forest conditions are poor. The land is held in large bodies, and only to a small extent is owned by farmers.

The principal forest industry is the cutting of chemical wood, which is extensive, and is rapidly clearing large areas of all forest growth. A few scattered portable sawmills still operate, but the former stationary mills are practically all abandoned. Extensive railroad logging has been carried on from Quaker and Red House runs, which meet the Allegheny below Salamanca, New York. One large mill on Quaker Run has been operated until recently, and there is still some hardwood timber to be cut.

KINZUA CREEK.

Kinzua Creek rises in the central part of McKean County, Pennsylvania, and flows into the Allegheny at the town of Kinzua, in the eastern edge of Warren County. It drains the high, rough plauteau country through a series of deep, narrow, gorge-like valleys, which have steep, rocky sides and little or no bottom lands, except immediately at the juncture with the Allegheny River. A feature of this region is the extensive areas of compartively level plateau between the stream courses. This is much more noticeable than in eastern McKean County, where the streams are more numerous and closer together, and the general topography rougher and more irregular.

The soil throughout is a sandy or clay loam of the DeKalb series and full of large sandstone and conglomerate rock fragments and masses. This latter condition is especially true on the steep valley sides and narrow ridges, where angular rocks ten to fifteen feet square are not uncommon. Water runs rapidly from these slopes, but the streams are usually clear.

The cleared land is confined largely to the plateau top, where some of the wider ridges have fairly fertile soils. Nowhere are the clearings extensive, and more than 90 per cent of the total area is still wooded. The farms are generally poor, the owners raising only enough for home consumption. They depend for a livelihood on the forest industries or on the oil and gas with which the country abounds.

The forest types originally consisted of the ridge type, characterized by beech, birch and maple, and the slope type, which contained hardwoods and hemlock with a little white pine. Near the main valley of the Allegheny, and a short distance up Kinzua Creek, oaks and chestnuts were the principal hardwoods on the upper slopes and ridges.

The country has been entirely cut over for lumber, with the exception of a few small virgin tracts. Most of the land is very badly burned and denuded or covered with a small young growth of hardwoods, with scattered cull hemlocks, or, in protected places, a fair understory of young hemlock seedlings. As usual, the burned areas often bear young aspen or fire cherry, either pure or in mixture. Another form of denuded land is that which has been cut over for chemical wood. Here the cutting has been so close that the lands look as though they had been cleared for farming.

Fires are frequent and have been very fierce in the past, when the country was newly lumbered and slash was present in great quantities. Now, over large areas, there is little or nothing left to burn; yet fires run through the hardwood stands and do much damage. There is naturally little humus over most of this territory, though the second-growth stands in places where fires have burned for several years have developed thin layers of humus. An exception to this condition is found along the narrow valley bottoms, where there is often a fair belt of forest, culled of its best timber, but containing a mixture of good hemlock and hardwoods. In such situations the humus is quite good.

Lumbering on any big scale is finished, and now large chemical wood mills are stripping the cull forests and second-growth stands at a very rapid rate. There are two such mills, one at Westline and one at Morrison.

Clearings for agricultural purposes over this region can never be extensive on account of the poor soil and rough country. Much of the land already cleared is now reverting, and will in the future become forest land. In fact, this is an absolute forest region and should be always kept under woodland cover.

CHAUTAUQUA LAKE AND CONEWANGO CREEK DRAINAGE.

This area, drained by Conewango Creek, includes the greater part of Chautauqua County and the western edge of Cattaraugus County, New York, and the north central part of Warren County, Pennsylvania. Conewango Creek rises on the low divide running parallel to, and from 7 to 14 miles south of Lake Erie, and joins the Allegheny at Warren. Cassedega Creek, its principal tributary, drains the section to the west, including Chautauqua Lake.

The country drained by this entire system is divided into a large northern district of gently rolling country of glaciated origin, and a small strip of land along the Allegheny River with rough topography. In the glaciated country the hills are rounded and low, and the valleys are broad and shallow, with sluggish streams meandering through their wide bottoms. The soils are deep and fertile clay or sandy loams. The land is largely agricultural, and the wooded areas are in small and scattered bodies. Waste land is here confined to swampy areas along the streams, where artificial drainage is necessary before they can be farmed. These areas are generally covered with a brushy growth of hardwoods and hemlock. The rest of the land is made up of rich and prosperous farms where orcharding, trucking and general farming are carried on. Owing to the low topography and the excellent condition of cultivated and grass lands, erosion is not perceptible. Waste lands only need drainage to bring them into productivity.

This region is primarily agricultural, and the wooded areas will always be confined to small lots on individual farms. The woodlots are in good condition, and, being surrounded by extensive bodies of agricultural land, fires are infrequent. The principal species found are beech, birch and maple, with a mixture of hemlock on the bottoms. There is very little white pine. The stands are all second growth and uneven-aged, with good density. They are the source of fuel wood and fence posts for the farms, and are preserved largely for that purpose. Lumbering is not carried on except by occasional, small portable mills. The present swamp lands are being drained and rendered available for farming.

The southern portion of the Conewango drainage is a deeply-dissected plateau region, with steep-sided valleys and high ridges. The stream valleys are comparatively narrow, and the streams run more swiftly and straighter than those farther north. The valleys, however, are not so angular as those to the south, where they have been entirely free from glacial influence. In fact, this is a sort of transition region, and is thought to have been subjected to glaciation at a period previous to the Wisconsin glaciation. It lacks the deep mantle of till, and glacial soils are confined to the valleys, where they occur as outwash or in various morainal forms. The soils are generally rather poor and sandy, with much loose fragmentary rock on the steeper hillsides. Good clay soils derived from shales are also found, but in irregular patches.

Farms are fairly prosperous and largely cultivated, though smaller clearings within the larger bodies of woodland are apt to be in grass. The wooded areas are of second-growth, and mostly of small size. Their density and general condition are good, and the humus fairly plentiful. Fire damage is slight. Birch, beech and maple are the prevailing species, with oak forming a large per cent on the slopes of the larger valleys, especially near the Allegheny. Hemlock is found in fair quantities, either as pure stands, or scattered with hardwoods on the hill slopes. White pine and chestnut occur sparingly.

Lumbering has not been carried on to any extent for many years, but the oil industry is quite important near Warren, and coal is mined in at least one place.

Much of the uncleared land will be kept in forest on account of the steep slopes, and in the case of the higher hills, on account of the infertile and rocky nature of the soil.

BROKENSTRAW CREEK AND OIL CREEK.

The drainage areas of these two creeks have many similarities in topographic, soil and forest features. Starting in the rolling glaciated region of southwestern Chautauqua County, New York, Brokenstraw Creek flows through the narrow belt of Warren residual soils and thence to the Allegheny through the angular topography of the DeKalb soil division. Oil Creek rises near the dividing line between eastern Erie and Crawford counties, Pennsylvania, and flows south to the Allegheny at Oil City. The region drained includes small portions of Chautauqua County, New York, Erie, Crawford and Venango counties, Pennsylvania, and the western half of Warren County, Pennsylvania. The wide valleys and rolling hills of the glaciated area where these streams rise give place gradually to narrower valleys and steeper slopes in the Warren soil series, and then to the sharp, rocky-sided, narrow valleys and sharp ridges in the DeKalb series.

The forest conditions follow closely the variation in soil and topography. In the glaciated area,

the lands are largely cleared, and the wooded areas are small and attached to the farms. The predominating species are maple and beech, with some birch and ash. Pine and hemlock are found in some of the bottoms. The woodlots generally are in fair condition, and not usually disturbed by fires.

The Warren area is a belt of residual soils of fair quality for farming, but without the smooth topography of the glaciated areas. The woodlands, therefore, are in larger bodies, there is more waste land, and the stands are more heavily cut over. The species most common are beech, maple, birch, ash, cherry, oak and chestnut, with some pine and hemlock on the slopes and in the bottoms. The stands are in poorer condition as to size of trees and density, and the humus is less complete.

The DeKalb area toward the Allegheny valley has a still greater proportion of forested land and has been more recently lumbered and very heavily culled for ties and props. The land being poorer, and valuable for oil, farming is of minor importance. The stands are apt to be open, and are often scrubby. The fire damage is greater, and humus conditions are poor. Oak and chestnut are the predominating species, though beech, birch and maple are also found on the broader uplands. Pine and hemlock occur on the cool, narrow valleys, and aspen stands are not uncommon on old burns. Pitch pine is sometimes found on sandy ridges. Lumbering to a small extent is still carried on. The steep valley sides and narrow ridges are thin-soiled and rocky, and only suited to forest growth. Nowhere in the region is erosion noticeable, but forests are necessary, and should be improved in the rougher portions, in order to help control run-off and to protect the land surface from further deterioration.

ALLEGHENY RIVER IN WARREN, FOREST AND VENANGO COUNTIES.

The main valley of the Allegheny through this region is for the most part narrow, with steep, rocky sides, in places almost precipitous. The bottom lands are in narrow strips, seldom over one-quarter of a mile wide, except near the city of Warren, and at other places where important tributaries join the river. The river itself is deep and wide, and meanders very considerably. Occasional low islands are found in its course. Most of the tributary streams are short, and flow rapidly through their gorge-like, rocky valleys to the main stream. The slopes are largely wooded, the few scattered clearings occurring where bottoms of small extent have made farming possible. The small towns along the banks of the Allegheny occupy narrow strips of level land, spreading up on the adjacent steep hillsides. The main farming sections are back on the hills and ridges, between the smaller side streams, and are devoted to general agriculture and grazing. The greater part of the wooded areas are too rough for agriculture, and, except where additional pasturage is needed, they should be kept in forest.

The slopes of the Allegheny valley are covered with a growth of mixed hardwoods, mainly oaks and chestnut, which have been heavily culled for ties, poles and props. White pine and hemlock reproduction is found in small quantities. Farther back from the river, the forests are of beech, birch, maple, cherry and hemlock, some of the timber being of fair merchantable value. Small areas of aspen have taken possession of burns. On some of the dry, sandy ridges, pitch pine is quite abundant.

Humus conditions are better on the ridges than on the immediate slopes of the river, where the stands are open on account of heavy cutting and poor soil. Burned areas are small, and the infrequency of fires is due in large measure to the wholesome public sentiment in the region against them.

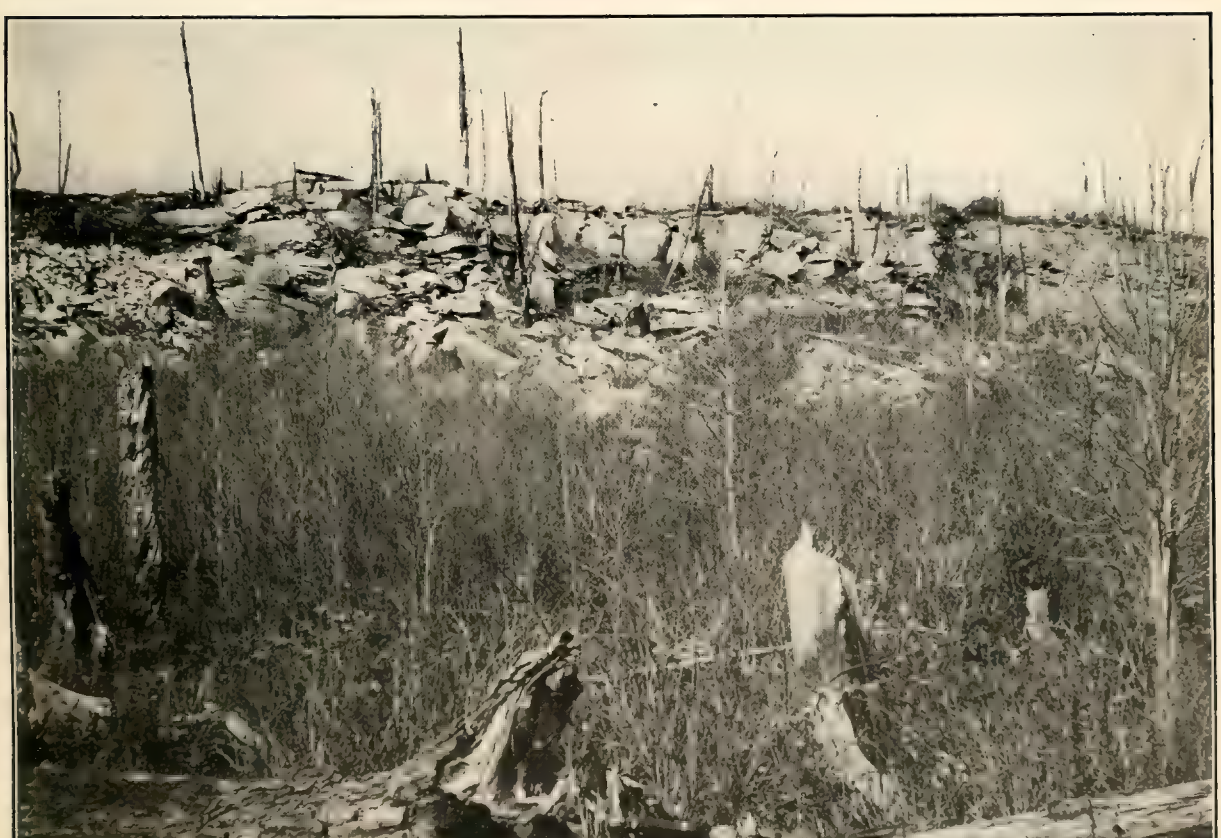
Except on the larger tributaries described, there is little or no virgin timber, and very few areas with timber suitable for manufacture into lumber. Hemlock Creek has some partially cut bodies of white pine and hemlock on its headwaters, and toward the lower Clarion drainage there are some very good woodlots of hardwoods and pine. The ownership of land is about evenly divided between small farmers and large land owners who are holding their property with the hope of striking oil.

TIONESTA CREEK.

This stream drains the greater part of the sandstone plateau country in Forest County and the southern part of Warren County, and is similar in character to the headwaters of the Allegheny River and Kinzua Creek, already described. Its drainage basin forms a semicircular area heading in the vicinity of the Allegheny near Warren, with branches on the east draining the country to the Clarion divide. Tionesta Creek joins the Allegheny in western Forest County.

The topography of this region is rough. The side streams are very numerous and have cut deep, narrow valleys which leave between them narrow, rocky ridges. The slopes and often the ridge-tops are frequently covered with very large rock fragments of conglomerate and sandstone, which

Culled Forest of Birch, Beech, Maple and Basswood.
Typical of the high plateau of northern Pennsylvania.



Brush Type
Showing the effects of logging and fires in the hemlock and hardwoods type on sandstone and conglomerate plateau of Northern Pennsylvania. Growth is now Fire Cherry and Aspen or Birch, Maple and Scrub Oak.

often resemble small buildings when seen from a distance. The soils belong to the DeKalb series, and are thin and dry. The valleys rarely have bottom lands, except at the junction of the larger tributaries, where the few towns of the region are located. The streams are narrow and flow over rocky beds. Tionesta Creek is rendered floatable for logs at times of high water by means of dams.

The region is almost entirely wooded or denuded, the farm lands forming only a very small proportion of the entire area. There is more virgin and merchantable timber land on this watershed than on any other tributary of the Allegheny, and although the production of oil is growing in importance, lumbering is still the principal industry. The farms are usually located in groups on the broader ridges and near the towns, where the condition of the soil and easy access to markets permit of a living being made from agricultural pursuits. There are also scattered "oil farms" or other clearings belonging to lumbermen. The same economic conditions are present as in the rough plateau country adjoining, except that here the lumber industry is more active and therefore creates a considerable demand for farm products. Much of the cleared land is used for pasturage.

While the streams run clear and erosion of the soil is not noticeable, the cutting and burning over of large areas has undoubtedly made the surface less absorptive and given rise to unequal and marked variations in the flow of water.

The forests consist of virgin hemlock and pine, second-growth hardwoods, and waste lands growing up to aspen and fire cherry. There are also very large areas of waste land which have been cut over and burned until they are practically devoid of forest growth. The lower and cooler slopes of the valleys form favorable sites for the growth of hemlock and the hardwoods which associate with it, presumably beech and maple. The upper slopes formerly contained white pine with oak and chestnut, while the dryer plateaus were adapted to beech, birch, maple, oaks, chestnut, cherry, and some ash and cucumber.

Owing to the prevalence of fires and the close lumbering of pine and hemlock, the oaks, beech, birch, maple and other hardwoods are taking the place of the mixed conifers and hardwoods of the original forests. White pine reproduction is exceedingly rare. The stands of second growth and the humus, where free from recurrent fires, are in better condition than on adjoining watersheds. The virgin stands are well protected from fires on account of their value, and hence the humus is deep over these areas.

The burned areas, however, are very extensive, the worst conditions being found along the line of the Baltimore and Ohio Railroad and in the northern part of the watershed. Fires sweep over these areas every few years and have entirely denuded much of the land. As seen from Sheffield Junction on the Clarion divide, the whole region for miles appears to be a succession of sharp, rocky ridges and deep valleys covered with small bushes, stands of fire cherry and aspen, or scrubby fire sprouts of the other native hardwoods, with small, scattered bodies of conifers in naturally protected sites. This is a condition typical of much of the northern Allegheny watershed. The railroads are responsible for most of the fires, though farmers burning brush have started some destructive and extensive conflagrations. Hunters probably start many fires also. The lumber operators are generally careful to prevent all fires that might threaten their holdings of merchantable timber. One operator at least has protected his property, including cut-over parts, from fire, and has even constructed a fire line to increase the efficiency of his protective system. He has also adopted certain phases of conservative cutting.

Originally this was one of the centres of the white pine and hemlock producing regions of the country, and it still contains some fair stands of virgin timber. These are gradually being worked out, but not rapidly exploited, and will last much longer than in any other section of the Allegheny watershed. The present proportion of forest and waste land to cleared land is liable to remain about the same in the future. New clearings are being made, but old farms are being abandoned as the lumber industry diminishes.

Lumbering is being extensively carried on by a number of concerns which operate logging railroads, and often draw their supplies from considerable distances. A great many of the smaller mills are near the end of their cut, however, and will soon close. The hardwoods, especially the lapwood from lumbering operations, and mill waste, are being used for chemical and pulpwood. Cut-over land is worth from $2 to $3 per acre, exclusive of oil rights. The land is in the hands of a comparatively few individuals and corporations, who own thousands of acres in continuous bodies. Among these owners the sentiment in favor of fire protection is increasing.

The better portions of the lands would give good returns in a short time if managed on forestry principles. The reforestation of the waste land, however, is a problem too big for any individual or corporation to handle, and should be solved by the State. Forest reserves should be located within

this region, in order to make the lands permanently productive and better to control the flow of the streams. The greater part of the watershed is too rough for agriculture, and may be considered absolute forest land.

HICKORY CREEK.

Hickory Creek drains an area in Warren and Forest counties between Tionesta Creek and the Allegheny River. Though small, it merits a special description because of the exceptional forest conditions existing on its drainage. Near the junction with the Allegheny River, Hickory Creek flows through a comparatively wide bottom land, which begins at Endeavor and extends to East Hickory. Through this bottom the banks of the creek are low, but the valley walls are steep-sided and rocky. Above Endeavor, the stream divides into many branches, with the valleys of each branch narrow and steep-sided and with the water running in rocky beds. The farms are of no consequence, and the cleared areas are mainly grass land.

Due to the protection given by the lumber company, which owns practically the entire watershed, the forest conditions over the area are excellent. This company has kept fire from its land for over thirty years, and in the last two years only 30 acres have burned over. Patrols are maintained and fire lines constructed. If a fire starts, the entire force of men is available to extinguish it. Extreme care in lumbering, together with fire protective measures, has given very noticeable results. There is a fine second-growth of all species, and the presence of a large per cent of young coniferous growth is in marked contrast to the condition of other localities where the forest at best is reverting to hardwood growth.

There are still large stands of virgin pine and hemlock in these holdings, besides second-growth stands of the same species. The ridges are mainly of oaks and chestnut, with some beech, birch, ash and maple. Birch is very common in the stream valleys, and sometimes forms nearly pure stands of second-growth. The young white pine, unfortunately, is badly infested with the weevil. The humus conditions throughout this watershed are excellent.

The sawmills of the company are located at Endeavor, and a logging railroad is in operation. Chestnut is sold for tannin extract, and mill waste and lapwood are disposed of to pulp and wood chemical companies. There is also a broom handle factory at Endeavor, which utilizes beech, birch and maple.

The results here of forest management and close utilization to prevent waste are in marked contrast to the denudation and almost criminal waste which have marked the passage of the lumber industry of western Pennsylvania.

FRENCH CREEK.

French Creek is one of the longest of the Allegheny tributaries, and drains the entire northwest corner of the Allegheny watershed, from the divide near Lake Erie in western Chautauqua County, New York, south through Erie, Crawford, Venango, and part of Mercer counties, Pennsylvania, joining the Allegheny at Franklin. Cussewago, Sugar and Muddy creeks are the principal tributaries.

This drainage area is for the most part one of moderate topography, rolling hills and broad valleys, with wide bottoms through which the rather sluggish streams meander. Practically all of this watershed, except its eastern and southern edge, has been glaciated, and glacial forms, such as eskers, kettle holes and moraines, are common, while in places the deposits of glacial till have interfered with drainage and formed small lakes and swamps.

The soil is mostly glacial in origin, and consists of a layer of till of varying depth, composed of fragments of the original shales and sandstones ground up and reworked in mixture with debris from father north, often in the form of worn and rounded cobbles and boulders. This process has given rise to a series of fine-textured loams and clays. The extensive Volusia soil area is bordered by a narrow belt of Warren residual soils, derived from the Conewango grey shales and thin-bedded, fine-grained sandstones. All these soils have good agricultural properties, and the entire region is largely devoted to farming. The DeKalb unglaciated region, with its rough topography, extends north for a short distance above Franklin and takes in the lower reaches of French Creek.

Since this watershed is so largely agricultural, the wooded areas are necessarily small, and occur in the form of scattered woodlots. The cleared land is given up to general agriculture, with dairying as the foremost industry. Much of the land is in grass, though other crops are extensively raised.

The moderate topography and the large proportion of grass land prevent any serious erosive tendency; while the woodlots occurring, as most of them do, on the steeper slopes and at the heads

of streams, undoubtedly act as a valuable check to rapid run-off. The streams, however, frequently flood the broad, low bottoms along their banks.

The woodlots are located more or less irregularly in long, narrow strips on the hills, particularly on the steeper slopes at the heads of streams and in swampy areas along the streams. The prevalent type on the uplands is mixed maple, beech and birch, though pure groves of sugar maple are abundant, and oaks and chestnut grow with all species. Ash and cherry often form considerable parts of the mixture, especially where maple and beech are the prevailing species. Hemlock reproduction is often found with the mixed hardwoods on the slopes, and in the wet bottoms it is the principal species with elm, willow, beech and maple. White pine occurs in the lower valleys and on the slopes, but is nowhere abundant. The forest conditions are generally good, though sometimes the woodlots are badly culled and brushy, especially toward Sugar Creek.

In the rougher Warren area the bodies of woodland become larger, increasing in size toward the southeast. Waste land and poorer stands of timber are more common until in the DeKalb area, though small in extent, the general forest conditions are those of a cut-over region. This is the only part of the watershed with any large amount of waste land which should be kept in forest. The humus conditions vary in like manner, being very good in the woodlots and much less so in the young and open stands on the DeKalb soils. Fires have not been destructive.

The lumbering is confined to a very few small mills which cut entirely for local consumption. Fuel wood has considerable value, as there is no coal, gas or oil over the glaciated part of the watershed. Posts and other rough timbers are used locally on the farms. The application of forest management should be directed largely toward maintaining the woodlots so that they may continually produce the materials needed on the farms.

SANDY CREEK.

Sandy Creek drains the country south of the French Creek watershed and west of the Allegheny, and flows into the Allegheny south of Franklin. More than half of the upper course of the stream is in the glaciated region, while the lower part and the mouth are in the region of rough topography characterized by the DeKalb soils series.

The same descriptions apply to the upper half as were given for French Creek, except that there is a noticeable absence of conifers. The lower part is within the oil field, and the demand for mine props has caused the woodlands to be heavily cut over. Lumbering is being carried on to some extent. The prevailing species are oaks, chestnut and maple, with some hemlock and but little pine. The trees are small and the stands open, so that humus conditions are poor. Fire damage has not been heavy.

EAST SANDY CREEK.

East Sandy Creek joins the Allegheny from the east, and drains a small section of Clarion County and the southeastern part of Venango County. The country is for the most part of rough topography, with almost precipitous stream valleys, but there are numerous large areas of high, level plateau land toward the headwaters. Toward the southwest the topography becomes rolling and rounded, characteristic of the lower Clarion drainage. The soils are all in the DeKalb series, and tend to be rather sandy. The cleared lands, however, are well cultivated, and there is no great extent of waste land.

The western portion of the drainage area is more or less cleared and contains good farms. Small areas around the villages in the more wooded section to the east are also well cultivated. Cut-over woodland forms a large proportion of the remaining area. The predominating forest type is oak and chestnut, with white oak as the leading species. Hemlock and pine are found scattered in the valleys and on the slopes. Small pure stands of merchantable white pine occur here and there, and also pitch pine on the drier, sandy ridges. The trees are of fair size, and the stands are in good condition, except where badly burned. Fires have covered large areas, sometimes killing the timber, and invariably destroying the humus on the steep slopes of the stream valleys. These slopes are rocky, and are absolute forest lands. They should, therefore, be kept in good forest growth.

CLARION RIVER.

This stream is one of the most important of the Allegheny tributaries and drains a large territory, comprising central Clarion, the southeast quarter of Forest, the greater part of Elk, a small portion of Jefferson, and the south central part of McKean County. The Clarion joins the Allegheny at Foxburg. In general, the region is a dissected plateau of rough topography, with streams

flowing in narrow, steep-sided valleys without bottom lands. It falls naturally into two divisions, the dividing line being a few miles northeast of the town of Clarion.

The northeastern division is almost entirely forested, and the topography is rough and generally unsuited to agriculture. The valleys are deep, with very steep, rocky sides, and where they are close together, the intervening ridges are narrow, very thin-soiled, and with large rock fragments. The farms are of little importance, and the owners work most of the time in the woods or in the oil business. Many of the clearings are so-called "oil farms," surrounding the oil wells, and often in the process of reverting to woodland.

The greater part of the woodland is of second-growth hardwoods, with some scattered pine and hemlock. Conifers are found in appreciable quantities only in the few virgin tracts. The forests consist of virgin conifers, virgin hardwoods, second-growth mixed hardwoods, burns reverting to woodland, old fields reverting to woodland, and waste land. In the hardwood type, distinction may be made between those areas where oak and chestnut predominate, and those where beech, birch and maple are the most abundant. The virgin conifers are confined to a few tracts of hemlock and white pine mixed with hardwoods, which are rapidly being cut. The areas of virgin hardwoods are also small in extent, and are rapidly being converted into lumber and chemical wood. Second-growth hardwoods, with some larger scattered cull trees left after lumbering, comprise the greater part of the forest growth over the region. Hemlock and pine sometimes occur in this mixture, but never in large quantities. Old fields often grow up to white pine, and this type eventually forms very valuable woodland. The weevil has been quite injurious to the pines.

Much of the land has been badly burned after lumbering, and is now covered with dense stands of fire cherry and aspen. This is locally known as "red brush land." While the fire cherry never amount to anything commercially, the aspen may become valuable for pulpwood. The type is only temporary in character, and derives it chief value as a protective cover until the more tolerant species have a chance to reëstablish themselves. Large areas, especially on the steep slopes and rocky ridges, have been so repeatedly burned that they are practically devoid of tree growth of any kind and are now vast wastes, covered with bushes, vines, grass and weeds growing in small pockets of soil between the large rock fragments. In such areas humus is almost entirely absent, and even the soil has often disappeared.

The large burned and waste areas are the most noticeable feature of this region. The most serious fires occurred within a year or so after the various tracts were lumbered, and there was a vast amount of slash lying on the ground. In the earlier history of the region, the hemlock was peeled for the bark, and the logs left on the ground gave rise to uncontrolled fires. At the present time the trees are so closely utilized, even the tops being cut into chemical and pulpwood, that the fires are less fierce than in former years. A fire warden system and a more enlightened public sentiment have also helped to mitigate this evil. However, the fires on the whole are still serious. They prevent the reproduction of conifers and do a great deal of injury to the second-growth hardwood stands, keeping much land in a waste condition and increasing the proportion of this type of land. Virgin stands, since they contain valuable timber, are generally well protected from fire by the owners.

The humus conditions are variable, and on the whole very poor. The waste land has no humus, the old burns and fields reverting to forest have some, while the mixed second-growth hardwoods have amounts which vary with the density of the stands and the frequency of fires. In the virgin stands the humus conditions are generally very good, being better under conifers than hardwoods.

This region was once the center of a wonderful hemlock and pine forest, with large areas of virgin beech, birch and maple on the ridges. The lumber industry is nearly at an end, and oil, gas and coal are leading in importance. The principle forest activities at present are the production of lumber, bark, pulp, chemical wood, railroad ties and mine props. The largest tract of virgin timber will be worked up by mills in another watershed, and the lumber industry in the future will be represented by portable mills cutting small bodies of timber or working over the culled areas of former operations. The operators utilize all wood very closely, cutting to a small diameter and utilizing the tops and cull trees for ties or pulp and chemical wood. Slabs and edgings at the mills are also sold for the latter purposes. Besides using the waste from lumbering, the paper and chemical wood operators are cutting over their own virgin or second-growth hardwood tracts. The areas are cut so closely and cleanly that practically no tree growth remains, and the result is a regeneration by sprouts, unless fire converts the cuttings into waste land. The areas of virgin forest will soon be gone, and if the country continues to be cut over closely for chemical

VIRGIN SPRUCE FOREST WITH SOME BEECH, BIRCH AND MAPLE
At the headwaters of the Cheat River in West Virginia.

SPRUCE TYPE AFTER LOGGING AND DESTRUCTIVE FIRES.

and pulpwood, and fires are not stamped out, the whole territory will ultimately become a denuded waste.

It is not likely that much more land will be cleared for farms, since so much of it is unfit for agriculture, local markets are not large, and transportation is difficult. Many farms which were run to supply the lumber camps are being abandoned, so it is likely that the proportion of cleared land will remain about the same for many years to come. Large areas are held by individuals or corporations for their future value in oil, gas and coal. Exclusive of mineral rights, rough cut-over lands are worth from $1 to $3 an acre.

The southern and southwestern portion of the Clarion watershed is less abrupt in character, shale soils take the place of hard, capping sandstones, and the country is largely devoted to agriculture. Grass land comprises about 60 per cent of the area. The steep slopes along the Clarion River and a few of its larger tributaries are the only areas continuously wooded. The soils for the most part are clay loams of good depth, and suitable for general farming, though the larger proportion of rougher land is used for pasturage or grass.

The forests of this region are mostly in the form of small woodlots, except in the main valley and some of the deeper tributaries, whose steep slopes are entirely wooded. The prevalent forest type is mixed oaks and chestnut, but hemlock is also found in considerable quantities on the cooler slopes, and white pine is establishing itself on old fields, often in dense, pure stands of surprisingly good growth. There is a fair proportion of beech, birch and maple, especially in the valleys.

The woodlots, on the whole, are in very good condition. There is not a great deal of timber suitable for lumber, but the second-growth of tie size is abundant. Humus is present in fair quantities, as the stands are usually dense and fires infrequent, and the areas burned are of small extent.

Lumbering forms no important part of the industries of this southern division. Mine timbers are cut along the Clarion and shipped down the river in flatboats during the spring freshets.

RED BANK CREEK.

Red Bank Creek drains a parallel strip of country between the Clarion River system on the north and the Mahoning Creek drainage on the south. It extends east to the Susquehanna divide in Clearfield County, and includes the greater part of Jefferson County, southern Clarion, and the northern edge of Armstrong County.

The amount and location of cleared land vary according to the topographic features. The headwaters are on the high, wooded plateau, capped with massive sandstones, so frequently mentioned under the Clarion and other drainage areas. Below DuBois the country becomes greatly dissected, and the main valley is rocky and gorge-like, but the bordering uplands improve in agricultural value. The central and lower drainage area is primarily agricultural; the soils are derived from shales, limestone and sandstones, and are deep and fertile. This area is deeply cut by tributary streams, whose slopes are too steep and rocky to farm, and these slopes are wooded. Toward the Allegheny River there is a larger proportion wooded than where the topography is more rolling through the central drainage area. Probably over one-half the cleared land is in grass. There is much waste land around the coal mines near Reynoldsville, and also in the northeastern edge of the watershed.

This watershed may be considered to be the first to show noticeable signs of gullying and washing, which, though not extensive, are apparent on some clay soils which have been cleared and are now waste. The farm lands vary greatly in fertility, depending on the relative proportion of sand to clay in the soils and the depth of the soils. The best farms are in the central parts of the watershed, and are of excellent quality, considering the hilly nature of the country.

The forests of the region are of mixed second-growth hardwoods, with white pine and hemlock associated in the valleys and on old fields. The small proportion of conifers is probably due to very severe cutting and bad fires, just as chestnut is also rare in places which have been frequently burned. On the whole, oaks and chestnut are the prevailing upland mixture, though beech, birch, maple and cherry are sometimes found with them, especially on the better soils. Ash, hickory and cucumber occur sparingly. Woodlots in the farming sections are generally in good condition, with fair humus. A few small lots of virgin pine and hemlock still remain. The lower valley of Little Sandy Creek is well wooded with mixed hardwoods and hemlock.

The demand for mine props has caused the larger forest areas to be cut so often and thoroughly that only very young growth remains. Fire also has swept over much of the cut-over land, leaving it practically denuded. Extensive areas of popple, fire cherry, fire sprouts of oak, and even entirely

waste land with nothing but berry vines, weeds and grass are noticeable, especially at the headwaters above DuBois. Humus conditions are necessarily poor in these lands.

While the lower part of the north fork drainage is well cleared for agriculture, the upper course, approaching the Clarion watershed, is a recently lumbered country. Second-growth hardwoods cover the slopes, except where areas have been cleared for pastures, or the land has been denuded by repeated fires. Bare stump-land areas are characteristic of all the headwaters.

This was originally a region of wonderful pine and hemlock forests, but the few lumber operators still remaining are now almost cut out. While the presence of coal reduces the demand for cordwood, the mining industry has so stimulated the demand for props and rough timbers that much land has been practically cleared which is unsuitable for farming and must naturally revert to woodland. This will, in a large measure, make up for any agricultural land on the more recently lumbered headwaters which may later be cleared as the country becomes further developed. The presence of valuable mineral rights has to some extent discouraged the use of the land for farming.

MAHONING CREEK.

This stream rises in the divide of the Allegheny and Susquehanna waters in western Clearfield County, and flows south and west through southern Jefferson and northern Indiana counties. It passes in its lower course some of the most prosperous agricultural sections of western Pennsylvania, and joins the Allegheny in northern Armstrong County. The principal tributary is Little Mahoning Creek, which rises in northeastern Indiana County, joining the Mahoning near the northwestern corner of the same county. The Mahoning drainage basin is approximately parallel to that of the Clarion and Red Bank, which are north of it.

The topography changes in a marked degree in passing from the headwaters to the lower course of the river. In the plateau which separates the streams flowing to the Allegheny from those of the Susquehanna watershed, the country is high and only slightly eroded, with an elevation of from 2,000 to 2,500 feet. It is not mountainous, but the slopes become abrupt and the character rugged as the streams cut their way to lower elevations. The divide between the Mahoning and the Red Bank toward the headwaters does not differ topographically from the main divide. The slopes are vast, burned-over, stump or waste areas, often entirely denuded, and rarely in cultivation. The summits of the divides are wide plateaus, frequently in cultivation or pasture, but more often only cut-over and denuded. Coke furnaces and coal mining operations on the slopes about Punxsutawney and elsewhere are largely responsible for this condition.

There is practically no erosion on the headwaters. The soil is hard and thin, often rocky, and invariably with the bed rock close to the surface. Sandstone prevails on the high divides, and the surface is often covered with immense masses of conglomerate and loose sandstone rocks.

South and west of Punxsutawney the valley of the Mahoning becomes deep, and in places broad, with steep, wooded slopes, back of which are agricultural areas of great value. The creek valleys which join the Mahoning are narrow and deep, and the country between is rolling, with good soil, and is largely in small, well-cultivated farms and woodlots. The Little Mahoning is almost entirely agricultural, and is marked by rounded valleys and steep slopes. The Mahoning differs from the Red Bank and Clarion in the increased amount of bottom land along its course.

Farm lands do not erode appreciably, even though clearings are carried to the summits of the slopes. Erosion is most noticeable along roadways. Occasionally gullies occur, after excessive freshets, but almost invariably they seed over to grass during the following year. Two-thirds of the cleared land is in grass. There is very little waste land in the lower drainage area, but the amount increases toward Punxsutawney, where the sandstone ridges predominate, and where mining has been or is now being carried on.

The forest condition varies from a region of brush, stump land, and second-growth hardwoods covering immense areas at the headwaters and on the divide between the Red Bank and Mahoning, to one of small woodlots toward the Allegheny River, and over the southern drainage in Indiana County. At the headwaters the effect of recent logging is conspicuous. The stump lands are in pasture, and there are large burned areas with no reproduction of value, and with humus destroyed. Formerly there were immense areas of hemlock, white pine, chestnut and other hardwoods. The hemlock was cut for its bark, and the stubs and charred logs still remaining indicate the immense waste of timber in former times. More than half of these cut-over lands have not become reforested with growth of any value.

Toward Indiana and Armstrong counties, the watershed has been cleared and cultivated for many years, and the woodlands are confined to steep slopes along creeks, and very small lots on rolling

land. These small woodlots are generally in fair condition, with few fires and plenty of accumulated humus. Oak, beech, maple, chestnut, hemlock and birch predominate. White pine is not abundant, but is found on Mudlick Creek and elsewhere in scattered clumps. At the higher elevations, birch, beech and maple are mixed with hemlock. Oak and chestnut prevail on the drier slopes. On the steep, cold slopes of the creeks, hemlock forms the largest proportion of the growth. There is considerable ash, hickory, and some cucumber in the bottoms. Woodlot conditions improve away from the mining operations toward Indiana County, where there is less demand for wood. The slopes of Mahoning Creek are well wooded with hardwoods and hemlock, and small logging operations are still carried on. Culling is more common than absolute clearing. There is no virgin timber, and woodlots are in the hands of farmers. At the headwaters immense areas are owned by coal companies.

CROOKED CREEK.

This is a comparatively short tributary of the Allegheny, lying between the Mahoning and the Kiskiminetas watersheds and draining the west central portion of Indiana County and the southeastern part of Armstrong County. Its course lies entirely within a prosperous agricultural section and is representative of a number of smaller streams which flow directly into the Allegheny, such as Cowanshannock, Big Pine and Buffalo creeks. The topography is rolling, with roundtopped hills, abrupt slopes, and deep, narrow stream valleys. Toward the heads of the streams, the rolling hills are less abrupt, and the valleys wider and shallower.

The soil is derived largely from a fine-textured shale which disintegrates readily. There are outcrops of red shale, sandstone and limestone; the last often burned for fertilizer or used for building purposes. Coal is mined for local use. Along some of the larger branches there is considerable alluvial soil. The farms are in excellent condition, and there is very little waste land or indications of erosion.

In a section so largely under cultivation, the woodlots are located at irregular intervals, sometimes occurring as fringes along the crests of the ridges, or on the flats along the creek bottoms. The largest wooded areas lie on the steep slopes of the valleys, particularly along the lower course of Crooked Creek and the greater part of Buffalo Creek. Brush land is of little importance. The woodlots are entirely of second-growth, since the old timber was long ago removed. Frequently the trees are scattered, limby, and worthless except for shade. The principal species are white, chestnut black and red oaks, chestnut and maple, with an undergrowth of dogwood, sassafras and witch hazel. There is also much scattered locust and beech, but hemlock and white pine are rare, and chestnut is not abundant. There are some stands of almost pure black oak. In spite of the open condition of the woodlots, the freedom from fires has resulted in good humus conditions and excellent reproduction. There is very little cutting, except for mine props and small timber for local use.

KISKIMINETAS RIVER AND TRIBUTARIES.

The drainage of the streams which make up the Kiskiminetas River extends from southern Armstrong and central Indiana counties east to the escarpment of the Allegheny Mountains in eastern Cambria and Somerset counties, and south to central Somerset and Westmoreland counties. This area includes the northern extension of the Laurel and Chestnut ranges. The most important tributaries are the Conemaugh River and Loyalhanna Creek; the former includes several large branches. The Kiskiminetas proper begins at the junction of these two streams and extends to the Allegheny River.

This is a region of great agricultural and commercial activity and is located well within the soft coal region. Except at the headwaters of most of the streams and on the steep slopes of the intervening ridges and watercourses, the country is largely agricultural. In no part of the entire Allegheny watershed has denudation been so complete or disastrous as in certain sections along the Conemaugh River.

The topography varies from a high, gently-rolling plateau at the headwaters, the elevations ranging up to 2,800 feet, to a low, dissected region less than 1,100 feet in elevation, marked by narrow, steep-sided valleys, and with high intervening ranges of mountains, through which some of the streams have cut narrow gorges.

Along the Kiskiminetas the soil is generally deep and porous, and, except on steep slopes, the underlying shale rocks are not exposed. Erosion, except as gullying along some highways, is not conspicuous. The land is so nearly cleared along the lower course that the forest growth is confined to small inferior woodlots. These are badly culled, and consist of oak, with chestnut, ash, hickory and maple in mixture. Beech grows sparingly along water courses and locust is common in the fence

rows, and on brushy waste areas with dogwood, sassafras and other species. Hemlock and white pine are occasionally found in groups, but are not abundant.

The important tributaries of the Kiskiminetas River will be described separately.

Conemaugh River. The Conemaugh River rises in the Allegheny Mountains of eastern Cambria County, where the elevation ranges from 2,000 to 2,800 feet. The South Fork is the principal source, and flows northwest from the uniformly wooded slopes of the divide and joins the Little Conemaugh from the north, which drains a portion of the divide somewhat less uniformly wooded. From the junction of these streams, the western course of the Conemaugh is gorge-like through the elevated tablelands and the intervening mountain ranges. The city of Johnstown is in this narrow river valley. The high divides are rolling and much less abrupt than the lower country, where the river has cut through the soft shale plateau and the rough sandstone ranges. West of the mountain ranges, the Conemaugh valley broadens into a lower rolling country, and in that section is joined by Black Lick and Loyalhanna creeks.

The effect of denudation is nowhere else on the entire Allegheny watershed so apparent as along the main course of the Conemaugh. The steepness of the slopes, the heavy, poisonous fumes from the furnaces, which constantly settle over the valley, and the absence of timber and in some cases any kind of growth, give rise to a condition approaching devastation. In some places the slopes are nearly perpendicular, and frequently, near Johnstown and other sections, have not even a covering of grass. Scattered locust, sumac, alder, aralia and a thin growth of weeds and grass are almost the only covering for long distances. The stumps and burned trunks of oak, gum and chestnut indicate the character of the original forest. The shale rock comes close to the surface on these slopes, and humus is entirely absent. Erosion is noticeable, but nowhere as extensively as would be expected under such unfavorable circumstances. Away from the vicinity of the furnaces which border the valley the steeper slopes are for the most part wooded.

Back of the gorge-like valley of the Conemaugh and the streams which feed it, the country is high, rolling, and either extensively cultivated or in waste. Between Johnstown and the headwaters of the Conemaugh there is a plateau rising gently to 2,300 feet, which is extensively cleared and in cultivation, with very little waste land. On this plateau the woodlots are often in excellent condition. East from this section, toward the headwaters of South Fork, the cleared areas decrease in size and importance and the country becomes largely wooded. The Little Conemaugh, flowing from the northeast, is more or less in cultivation to its headwaters. Oats, rye, barley, wheat, potatoes and corn are the principal crops raised. In the vicinity of Cresson, where the main line of the Pennsylvania Railroad crosses the divide, there is a large amount of waste land and many small mining towns. Extending north toward Ebensburg, at the head of the Little Conemaugh, there is much good agricultural land.

Along the railroads, particularly the main line of the Pennsylvania, the woodland has all been burned over. Although fires do not occur every year, they burn periodicaly over the greater part of this region where the wooded areas are extensive. The forest growth is almost entirely mixed oaks, beech, birch, maple and other hardwoods, with some patches of young hemlock. Basswood and tulip or yellow poplar are scattered. Locust occupies large areas of abandoned land. Chestnut is not abundant, and white pine is practically absent. At high elevations on plateaus and the main divide, beech, birch and maple form the principal type, but where fires have not occurred there are occasional excellent stands of young hemlock. All these species are being cut to some extent for lumber, but the land is also culled for mine props and pulp wood.

The Laurel range, west of Johnstown, rises to an elevation of over 2,600 feet, and is almost entirely wooded as far north as the Conemaugh River. Above this point the range broadens and becomes a part of the rolling plateau, and is more extensively cultivated. Large areas are denuded of timber, badly burned, and now covered with brush. In such places the humus is entirely lacking and the underlying rocks are exposed. Erosion has not taken place to any extent.

West of the Laurel range there are many excellent farms, but the proportion of waste land is equally large. This is particularly noticeable where the hills have been tunneled for coal and the water table lowered in consequence. The crests of these hills above the tunnels are invariably abandoned to weeds, briars and locust. They even cave in for long distances, and where they were in excellent condition before the coal was removed, they are now useless for farming. The owners devote most of their time to mining, and farming is not carried on in the prosperous way commonly seen in a purely agricultral section.

Stony Creek. This tributary of the Conemaugh drains the northern half of Somerset County, flowing north into Cambria County and joining the main stream at Johnstown. Quemahoning and

Partially Culled Forest of Hemlock and Hardwoods.
Common on the steep, rocky slopes along the creeks.

Hardwood Type.
Chiefly Chestnut Oak, Chestnut and Birch, on the ridges in Maryland and West Virginia.

Shade creeks are the largest forks of Stony Creek. This drainage, like most of the Conemaugh watershed, is a mining country. The streams have a characteristic yellow color, said to be due to the sulphur in the mines, and many of them are polluted and filling up with coal dirt. The valley of Stony Creek lies in an elevated and rolling plateau, bordered on the east by the Allegheny Mountains and on the west by the Laurel range, which parallels the Alleghenies northeast and southwest. The slopes of both ranges are gentle on the inside. Through this plateau the creek has cut a narrow channel, which deepens toward its junction with the Conemaugh.

Except on the ranges, the country is largely agricultural, although mining is probably the most important industry. The soil is derived from shale, and is deep and fertile. The bordering mountains are steep and generally rocky, and of no value for agricultural purposes, except on the more gentle slopes, where the soil can be sown to buckwheat and oats. Erosion is not noticeable.

The slopes of the mountains are almost entirely wooded, while the plateau country between is a woodlot section, with the small timbered areas occupying the steep slopes and the minor divides. The mountains are practically all cut over, and if not denuded, are mostly in second-growth hardwoods—white, chestnut and red oaks, maple and chestnut predominating. Hemlock is scattered, and confined mostly to the ravines and lower slopes. On the broad summits there are occasionally flat, swampy areas where extensive forests of hemlock have been cut, and which are now almost entirely denuded. Where fires have not been serious, there is a dense undergrowth of rhododendron. The best of the present cover on these mountains will yield saw-timber, poles, ties and mine props. Being in a coal mining section, there is little demand for firewood. Railroads have been responsible for many fires which have burned extensive areas. During 1908, the fires were particularly numerous and disastrous. Humus conditions are fairly good where repeated fires have not occurred. In the woodlot section, between the mountain ranges, the timber is frequently of considerable value. Along the banks of Stony Creek there are many areas of excellent hemlock. The oak type predominates in these woodlots, while birch, beech and maple are confined to the minor ridges. As is commonly the case, fires have done less damage than on the mountains where wooded areas are continuous and the soil is thin.

Large tracts are owned by private individuals, mining and railroad companies. About 4,000 acres in the Laurel range are located in one of the Pennsylvania Forest Reserves. The Pennsylvania Railroad controls a number of water supply reservoirs. The tendency of these large owners is to prevent fire and maintain the mountain lands in forest growth. A few sawmills still continue to operate, but the lumbering industry has practically ceased. The rough, steep lands are worth from $2 to $5 per acre when cut over.

Black Lick Creek. This branch of the Conemaugh River drains southeast Indiana and west central Cambria counties. It rises in the main divide of the Allegheny Mountains and flows to the west through the Laurel and Chestnut ridges, nearly parallelling the Conemaugh and joining it a few miles west of Blairsville. Two Lick Creek, a tributary from the north, drains the larger portion of southern Indiana County. The plateau at the headwaters of Black Lick Creek has an elevation somewhat less than that at the headwaters of the Conemaugh. The cleared land largely occupies the high flats on these headwaters, and mining is an important industry. Toward Indiana County on the west, agricultural development increases, and the forest becomes broken into smaller woodlots. West and south of the town of Indiana, the country is largely cleared. The general topography is rough, and marked by narrow, steep valleys, with shallow, rocky stream bottoms, back of which are steep hills and rolling tablelands.

The Laurel and Chestnut ranges are less pronounced than south of the Conemaugh River. They flatten out into broad tablelands, which are more or less cultivated, except on the steeper slopes. East of Two Lick Creek, Chestnut ridge contains extensive areas of wooded lands on the west slope and in the ravines. Near the junction of Two Lick and Black Lick creeks, the valley broadens but has steep wooded slopes, which become only patches of woodland lower down toward the Conemaugh valley.

The soils are generally fertile, sandy loams and clays, with shale and sandstone outcrops on all slopes. There is considerable alluvial land in the wider bottoms of Black Lick and in pockets along the minor streams.

Agricultural conditions are generally fair, and there is much less denudation than on many adjoining watersheds. Although the slopes are steep, they are usually wooded, and the woodlands are in good condition. The proportion of waste land, however, is large, even where agricultural conditions seem to be good. This indicates that neglect rather than poor soil is responsible. Equally good conditions do not prevail at the headwaters, where the soil on the high, rolling plateaus is thin,

and the proportion of sandstone is greater. There a large proportion of land is denuded or in waste, and the farms are of much less value. Erosion is noticeable only on neglected farms where the soil is deep and of a brownish, sandy loam character.

The forests of the headwaters consist of beech and hemlock, mixed with maple, birch and other hardwoods. They are practically all culled or in second growth, and much of the smaller growth is now being cut for mine props. White pine is frequently mixed with hemlock in the northern part of the watershed. Chestnut and the oaks, particularly chestnut oak, occupy some of the dry, warm slopes. The forest types may be considered intermediate between northern and southern Appalachian conditions. At lower elevations in the woodlot section, oaks, ash, maple, chestnut, locust and hickory are the principal species. There is practically no hemlock, beech or pine. The steep slopes in all parts of this watershed are characteristically wooded, and should remain so. There are many abandoned sawmill sites, indicating the extent of former logging. A few portable or stationary mills are cutting sawlogs and mine props, but there is very little forest activity at present.

Loyalhanna Creek. The streams which feed this creek rise in the southeastern part of Westmoreland County, between the Chestnut and Laurel ranges. The valley which separates these parallel ranges is, in reality, a rolling plateau, similar to that which separates the Laurel range from the Allegheny Mountains. The course of the Loyalhanna is through the Ligonier Valley, a region of great agricultural development and considerable coal mining activity. The course of the stream is quite narrow and the valley almost entirely cleared, except where it cuts through Chestnut ridge, between Ligonier and Latrobe. In its lower course, the Loyalhanna emerges into a broad, rolling, agricultural country, and at Saltsburg meets the Conemaugh to form the Kiskiminetas River.

The valley soil is derived from sandy shales with frequent deposits of limestone. Toward the mountain ranges, the soil becomes thinner, and shale and sandstone outcrops are more frequent. The general topography of the valley is rolling, with the precipitous slopes of the ranges on either side. Cultivation is general, except on the ranges, where a few clearings have been made, but where most of the land is rough and wooded. Nearly every farm is supplied with a coal vein which furnishes coal for home use.

The valley region contains only scattered woodlots, which are badly culled for mine props. Toward the mountains there is much brush land and many abandoned farms. The mountain ranges are almost entirely wooded, but badly cut over. White, red and chestnut oaks, maple, chestnut, birch and hemlock constitute the forest growth. One section in the Laurel range, south of Ligonier and toward the headwaters of Indian Creek, is now being logged. There are other small patches of sawtimber, but these either are being held by private owners or the timber is being rapidly removed. Large areas in the cut-over section still contain good tie and post timber. The original growth on these mountains was mixed hardwoods and hemlock, the latter occurring in nearly pure stands on the flat summits and in the ravines. The country has not long been cut over, and twelve to fifteen years ago was still well wooded. Most of the cut-over lands have been repeatedly burned since lumbering. Railroads are responsible for most of the fires. It is generally recognized by farmers that the streams dry out more rapidly and completely during the summer months than formerly. Over many areas, however, there is a large amount of undergrowth and the humus conditions have not been seriously disturbed.

West of Chestnut ridge, the Loyalhanna passes through a rough, hilly section known as Dry ridge. Only the steepest slopes of this section are wooded; even these are often cleared. Most of the woodlands are badly culled or consist of brushy, second-growth species. Erosion in a few places is conspicuous. The humus conditions are poor, and at least one-third of the cleared land has been abandoned, much of it on account of tunneling for coal, followed by the caving in of the surface and the lowering of the water level. Between this section and the junction of the Conemaugh, the soil conditions and the farms improve, and the proportion of cleared and wooded areas is well balanced. The slopes are apt to be wooded, and there is consequently less chance for erosion.

The State Forest Reserve of 9,000 acres, mentioned under the Stony Creek watershed, covers 5,000 acres in the Laurel range within the Loyalhanna drainage. Several large private tracts are protected from fire by rangers, and are under some form of forest management. These tracts are located on important divides and are of immense value in protecting the headwaters of the streams which flow from them.

MONONGAHELA BASIN.

The Monongahela Basin is drained by two main river systems, the Youghiogheny and the Monongahela, which unite at McKeesport, 15 miles south of Pittsburgh.

YOUGHIOGHENY RIVER.

Drainage of the Headwaters. The Youghiogheny headwaters lie largely in western Garrett County, Maryland, though some of the smaller streams rise just over the line in Preston County, West Virginia. This is a region of high elevations and parallel mountain ranges running northeast and southwest. The streams generally follow the troughs or valleys between the ranges, but uplifts have complicated the drainage by causing the main streams to turn often at nearly right angles to their natural valleys and cut through the ridges. From about Friendsville to Confluence, the Youghiogheny flows through a deep, fairly wide valley, with steep but fertile slopes and small amounts of bottom land. From Friendsville to Oakland the valley is gorge-like. The tributaries have similar gorge-like valleys where they cut through the ridges to join the main stream, but farther back they often flow sluggishly through wide, moderately-sloped valleys. These rapid changes from a quick-flowing course to one of gentle grade cause the streams to develop a physiographic feature typical of this country and known as "glades." These glades are swampy and composed of rich alluvial muck. The wide valleys of the region are really elevated plateaus averaging about 2,700 feet above sea level, and bounded by steep ridges reaching from about 2,800 to 3,000 feet.

While the larger valley bottoms and moderate slopes have fertile shale, limestone and alluvial soils, and are largely cleared, the steep slopes of the ridges and their tops, as well as the rocky, steep-sided gorges of the streams, have very thin, rocky soils, suitable only for forest growth. About one-half of the headwater country is wooded, and about two-thirds of the cleared land is in grass. It is not likely that much more land will be cleared. There is little badly denuded land, with the exception of an area on the headwaters of Cherry Creek, where fires have been especially destructive. Agriculture, which has been overshadowed by the relatively greater importance of the lumber business, is now the chief industry of this region.

The forests are practically all mixed second-growth hardwoods, with a scattering of pine, hemlock and spruce. The ridge type consists of open stands of red, chestnut and white oaks, chestnut, maple, birch and locust. Exposure to high winds, combined with fires and a poor rocky soil, have made these stands of poor quality. The timber is chiefly of value for poles, ties, and chemical and tannic acid wood. The better slopes were originally covered with white and red oaks, maple, chestnut, basswood, birch, yellow poplar and hemlock. Nearly pure stands of both hemlock and white oak were sometimes found. These stands have all been heavily lumbered, and the second-growth is only in fair condition, depending on the length of time since lumbering operations ceased and the severity of the fires which followed the cuttings. Very severe cutting and fires have decreased the hemlock reproduction so that it now forms only a small per cent of the young growth. Old cull trees of all species, left by the lumbermen, furnish material for tie cutting by the farmers during the winter. Many of the young stands are in very fair condition, and suitable for mine props. Oaks and chestnut predominate in such stands, with beech, birch, maple and hemlock in the small bottoms. Yellow poplar, hickory and ash help to make up the young growth. The uplands of the farming section around Accident and Hoyes contain woodlots in better condition than the more extensive areas of woodland found in the larger valleys and on the ridges. The swamps or glades along the valleys formerly were covered with white pine, spruce, hemlock, maple, birch and beech, but they have been heavily cut over and badly burned, so that now only an inferior growth is left.

Practically all the large cut-over areas have been burned, but the forest is now reëstablishing itself. The fire problem is becoming less serious as the lumbermen are moving out. A growing sentiment against fires and a better enforcement of forest fire laws are largely responsible for the improved conditions. Humus conditions are fair, except on the more recently lumbered and burned areas and on many of the barren ridge-tops. With proper fire protection, and care of the present second-growth stands, the conditions should steadily improve.

The few remaining virgin tracts are very small and isolated, and lumbering on a large scale has almost entirely ceased. Tie cutting is carried on quite extensively, and furnishes employment to the inhabitants when other work is slack. The number of coal deposits as yet undeveloped will insure a large demand for mine props in the future, and should help to make the second-growth stands of value as an investment.

While the farm lands and woodlots are owned by farmers, most large tracts on rough land are being held by outside parties because of the deposits of coal. Three small State forest reserves, with a total acreage of somewhat over 1,900 acres, have been established northwest of Oakland in Garrett County, Maryland.

A special forest investigation of Garrett County was made by the Forest Service about ten years

ago and published by the Maryland Geological Survey.* This report deals very fully with the forest conditions, and makes practical suggestions for the treatment of woodlands.

Casselman River. Casselman River is the eastern branch of the Youghiogheny headwaters, draining the northern central portion of Garrett County, Maryland, and southern Somerset County, Pennsylvania, and extending from the Meadow Mountain range of the Allegheny Mountains on the east to the Negro Mountain range on the west. These two ranges converge in central Garrett County, forming the head of the drainage basin of the Casselman, which is fed by tributary streams from both ranges. The elevation of these ranges is approximately 3,000 feet, and that of the Casselman valley between is not much less. It is in fact an elevated region between slightly higher bordering ranges, increasing in width and ruggedness north along the lower course of the stream. Extensive bottomland areas border the stream at intervals throughout its length. A peculiarity of these headwaters is the manner in which Big Piney Run, one of the eastern feeders, cuts its way entirely through the Meadow range, and encroaching on the waters of the Savage River, a tributary of the Potomac, has its source on the western slope of the Savage Mountains near the Mason and Dixon Line. From the wide rolling country between the Meadow and Negro ranges in Somerset County, the Casselman turns abruptly southwest through a narrow gorge in the Negro range, and joins the Youghiogheny at Confluence.

The soils at the headwaters are derived from shales, sandstones and conglomerates, increasing in depth and productiveness in the wider valley of Somerset County. The dividing ranges are made up of massive conglomerates and sandstones, with extremely shallow sandy or clay soils, covered with boulders and rock fragments. Limestone outcrops on high ridges, and coal is found throughout the watershed, in deep and shallow veins. The best soils in Garrett County are the sandy loams and clays from red shale formations along Big Piney Run east of the Meadow range. The shallow rocky soils, where cleared, are used for pasturage or cultivated for buckwheat, corn and garden crops. Between the ranges in Somerset County, the soils are sandy loams and clays, mostly derived from shale and fine sandstones, and are extensively cultivated to wheat, oats, corn, buckwheat and other crops. The best soils are largely in cultivation or grass, the pastures and buckwheat fields often extending high up the slopes of the ridges.

Mining towns are frequent, and the coal industry is increasing rapidly. Near mining towns, the country is badly denuded and marked by abandoned tunnels and caving surfaces. Areas not cleared are burned, and the humus covering destroyed. Near Garrett, in Somerset County, erosion about the mines is quite conspicuous.

In spite of extensively cleared and pasture areas, from two-thirds to three-fourths of the watershed is wooded. Much of this is partly or wholly denuded as a result of lumbering and fires, and mining operations. Woodlots prevail in the rolling agricultural sections, while the wooded areas are extensive on the mountain ranges, on the rough lands along many of the streams, and on much of the poor, sandy soil in Garrett County.

The characteristic type on the ridges is chestnut and oak, and on the slopes, mixed hardwoods, consisting of red, chestnut, black and white oaks, chestnut, maple, beech and birch. Hemlock, white pine, white oak and beech were formerly the prominent species in the bottoms. White pine in the Casselman valley was the first to be logged, followed by hemlock of great size. The valley type has long since disappeared. Spruce formerly occurred with pine and hardwoods in swampy areas near the headwaters of North Fork in Garrett County, but this has now been cut. Sugar maple thrives in the main Casselman valley, and many pure groves are cultivated as sugar orchards in the lower valley. The virgin timber has practically disappeared. Occasional mills in both Garrett and Somerset counties continue to cut mixed hardwoods, hemlock and other species. The larger concerns in operation ten years ago have now completed their cutting. In some of the woodlots of Somerset County, there are small virgin stands of white pine, hemlock and hardwoods, which their owners have preserved.

The woodlots, however, are almost wholly stripped of valuable timber for the mines. Where logging was carried on long ago, there is now excellent tie and mine timber, and considerable timber is still found on some of the steep, inaccessible ridges, where the cutting has been almost entirely for ties and mine timber.

The extensive forest areas on the mountain slopes are entirely cut over, and most of them so badly burned that the land is practically brush or waste, with humus thin or deficient. The fires of 1908 were particularly disastrous; nearly all of Negro range formerly cut over was burned at this time. Similar conditions exist on the slopes of Meadow Mountain. Many of the fires were set by railroads which follow the streams through the narrow gorges.

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*Maryland Geological Survey—Garrett Co., Baltimore, 1902.

Laurel Hill Creek, a tributary of the Casselman flowing from the north and draining a narrow strip along the southwest border of Somerset County, joins the Casselman at Confluence. Its headwaters are on the eastern slope of the Laurel range. The greater part of this watershed is wooded, the farms being located on the more gentle slopes at the heads of minor streams. While the forests have been heavily culled and often badly burned, some sections still contain good timber. From Casselman River to the section about the mines at Roswell and Etna, the country has been cut over for mine timber, although there is still some hemlock and hardwood timber of sawlog size along the creek. North of this, in the section about Metzler, in the Laurel Hills, are several thousand acres of fair white oak, chestnut, poplar and maple, valuable for saw-timber, which are being cut by one or two mills near Roswell. This section contains the only saw-timber of importance in the southern Laurel Hill region.

Lower Youghiogheny. From Confluence the Youghiogheny flows northwest through the Laurel Hills and Chestnut ridge, and at Connellsville emerges into the rolling agricultural and mining section of southwestern Pennsylvania. This drainage area includes eastern Fayette County, western Westmoreland as far north as Greensburg, and a portion of southern Allegheny County. West of the Youghiogheny and north of the mountain ranges, the drainage area is short and separated from the Monongahela by a low, rolling plateau. The Youghiogheny is fed from the east by a number of quite long streams which head on the slope of Chestnut Ridge. The mountain section, which includes the entire eastern part of Fayette County, is extremely rough. The course of the river is narrow, and the elevations rise from about 1,200 to 1,500 feet above the river level. Chestnut ridge and Laurel Hills in northeastern Fayette County are separated only by Indian Creek, a fairly broad stream, which flows into the Youghiogheny from the north. Northwest of these mountain ranges, which end abruptly near Connellsville, the Youghiogheny has a sluggish course, cut through the surrounding rolling hills. The rock-outcrops along the lower course are shales, limestones and sandstones, with fairly fertile sandy loams and clay soils. Sandstone is the chief rock formation on the ridges, with shale outcropping on the slopes.

The Laurel and Chestnut ridges are quite uniformly wooded, except along the principal roads, while the country north is just as uniformly cleared. The ridges are covered for the most part with brushy or pole stands of red, white and chestnut oak, and chestnut. Other species of less importance are maple, birch and walnut.

The country has been stripped for mine timbers, immense areas being held by mining interests for this purpose. Recently it has become necessary to import suitable timber from adjoining states, particularly West Virginia. The woodlot areas north of the mountains are largely brush and inferior hardwoods, with oak predominating. Locust seeds in on the waste and abandoned lands, together with elder, sumac and species of crataegus. Humus conditions on the ridges as well as in the woodlots are poor.

No part of the Monongahela or Allegheny watershed is so nearly destitute of wooded areas as the lower course of the Youghiogheny and the Monongahela approaching Pittsburgh. The cleared land is poorly cultivated, and fully one-fourth is entirely waste, not even producing grass suitable for pasturage. This condition is due to the coal and coke industry, which centers in this portion of Pennsylvania. Abandoned tunnels cause the surface to cave in and the soil to dry out. The soils are fertile, and in spite of the denuded and waste conditions, should be capable of high cultivation away from the mines. The coal industry, however, occupies nearly the exclusive attention of the people, and farming is subservient and of comparatively little importance.

MONONGAHELA RIVER.

West Fork River. The source of the West Fork of the Monongahela River is in Lewis County, West Virginia. The river is fed by minor tributaries, starting at the divide which separates the Monongahela waters from the Kanawha within this county and the minor divide between West Fork and Buckhannon Rivers in Upshur County. The section drained includes northeast Lewis, a small part of northern Upshur, the whole of Harrison, and a part of Marion County. The Tygart Valley River joins the Monongahela near Fairmont, in Marion County.

The topographhy is rolling and uneven, with deep, narrow valleys, steep slopes, and sharp ridges or rounded uplands. The ridges are often only narrow lines defined by sandstone outcrops. The valleys become shallower and the ridges less abrupt toward the lower course. The main divide is not high, and does not differ materially in topography from the watershed in general. The valley of the Monongahela is narrow, but steep in its upper course, widening toward Clarksburg. The tributary valleys are deep toward the Monongahela, but rise rapidly and become less abrupt toward the divides,

where the streams fan out into rolling uplands. The larger part of the topography is made up of medium and gentle slopes. The bottoms are narrow, except along portions of the Monongahela Valley.

The underlying rocks are brown and red shales, limestone and sandstone. The sandstone is responsible for successive rough, narrow ridge-tops, and steep slopes where outcrops are conspicuous. The lower slopes and valleys and gentle divides are covered with deep, sandy, clay soils. Upshur clays are found on higher slopes. Coal is found over much of the watershed toward the north, although not worked extensively except in scattered localities. The gas industry is an important one.

Erosion is little in evidence, and is confined largely to the Upshur clay soils. The narrow, rapid-flowing streams carry considerable sediment during high waters, but run clear throughout most of the year. The water rises quickly in the narrow valleys, often flooding the roads for short periods, and banks are sometimes gullied. On cleared slopes there is a uniform cover of grass, or a growth of vines and weeds, which effectively prevents erosion. Cultivated lands do not seem to suffer from erosion, though the steepest lands are usually in pasture or forest growth. Extensive grazing in the woods has been injurious to the soil and undergrowth.

The watershed is primarily agricultural, except along the headwaters, where the wooded areas are in somewhat larger bodies. Probably 90 per cent is cleared, of which amount about one-half to three-fourths is in grass or pasture, the remainder being devoted to the raising of wheat, corn, oats, potatoes and other crops. Harrison County is extensively cultivated. Stock raising forms an important industry, although considerable pasture land is reverting to forest, due, probably, to the development of the oil industry. Nearly all the farms are small, ranging up to 100 and 200 acres.

Since this section is extensively developed for farming and grazing, the wooded areas are in small, scattered lots on steep, rocky slopes and dry, gravelly uplands. Along the headwaters in Lewis and Upshur counties, the ridge land has less value for farming, and nearly one-half is still wooded. Steep slopes along the banks of the Monongahela River and its tributary streams are usually brushy. Some fair woodlots extend down the slopes to the water, but usually good farms separate the banks from the slopes of the ridges. The forest lands have been almost entirely cut over for lumber, mine props, poles and ties, though there is little demand for firewood. Lumbering operations were extensive twenty-five to thirty years ago, but at present only occasional loads of logs are hauled to the railroads for export. There is one tract of virgin timber, consisting of about 800 acres of oak and yellow poplar, near the divide in Harrison County. Poplar was formerly abundant but is not so now, even in the reproduction. Red, white and chestnut oak seem to predominate, while hickory, chestnut, maple, beech, yellow poplar and basswood are abundant in the hardwood mixture. On rough, stony lands the growth is largely oak. White oak and yellow poplar are largely confined to the deep, moist soils along creeks. Pine and hemlock are rare. A few saw-mills are in operation in the upper Monongahela Valley, but the timber comes from south of the Monongahela divide.

Tygart Valley River. The Tygart Valley River, which joins the West Fork of the Monongahela near Fairmont, West Virginia, drains a much larger area and has more important tributaries than the West Fork. Its chief sources are Buckhannon River and Middle Fork, which unite with the Tygart Valley River in Barbour County. These two streams and the headwaters of the Tygart will be described separately. The drainage of the Tygart Valley below this junction includes most of Barbour and Taylor counties and portions of Preston and Marion counties. A number of streams, such as Teters and Sandy creek join the Tygart Valley in its lower course.

The Tygart Valley River, from the junction, flows north through a deep and narrow rocky valley whose slopes are, for the most part, wooded. The river bed is filled with rock masses, and there is little bottom land in the upper course. Back from the valley, the country on each side is cleared, there are many small farms, and the hillsides are used for pastures. Toward the north, the Tygart Valley broadens and the elevations rapidly decrease. The soils are mostly thin and stony, and the ridges capped with sandstone.

Some of the smaller stream valleys have quite fertile bottom lands, but the best farms are on the rolling slopes on the DeKalb loam and clay soils. The country is less extensively cleared and cultivated along the Tygart Valley than along the Monongahela. The slopes are steeper, and the proportion of sandstone in the underlying rocks is greater. Wooded areas form continuous strips along some of these rough slopes and narrow ridge tops, where the land is too steep for cultivation or so extensively strewn with stones and boulders and bedded sandstones that grazing is impossible.

The best timber has been removed, and the culled stands consist of inferior red, white and chestnut oak, and chestnut mixed with other hardwood species. Yellow poplar and hemlock are frequent in the vicinity of streams. A number of small mills are cutting hardwood timber and hauling it to the Baltimore and Ohio Railroad, which follows the Tygart Valley River.

Pure Stand of Hemlock.
Formerly common in Northern Pennsylvania.

Second-Growth White Pine.
Not common on these watersheds.

Buckhannon River. Buckhannon River, a tributary of Tygart Valley River, rises in the main southern divide of the Monongahela watershed and flows north into the main river at Tygart's Junction. It drains nearly the whole of Upshur County, part of western Randolph and a small portion of Barbour County. The main southern divide of the Monongahela changes gradually from a rolling, agricultural plateau west, to a high, mountainous and forested region at the east. The headwaters of Buckhannon River lie on a high plateau midway between these points geographically, in elevation, and in the amount of forested land. The elevation of this divide in Upshur County is from 2,500 to 3,000 feet.

The courses of Buckhannon River and its tributary streams are through deep, rocky gorges in the south, but near the town of Buckhannon, in the northern part of Upshur County, the soil conditions improve, the slopes are less abrupt and rocky and the country becomes agricultural. The soils there are largely DeKalb clays and loams and Upshur clays, and extensive meadow bottoms extend along the streams. These conditions prevail along Buckhannon River from the vicinity of Buckhannon nearly to the Tygart Valley, where the topography again becomes abrupt and the slopes steep and rocky. The best farm lands in Upshur County are on the gentle slopes back from the creeks. The town of Buckhannon is the centre of a prosperous and thriving grazing and agricultural country. While the steep slopes of the creeks are wooded, the woodlots in the agricultural section back on the uplands are inconspicuous and often no more than scattered brush patches or abandoned fields which are reforesting.

At the headwaters in the south of Upshur County, the land is rougher and largely in forest, the clearings being confined to the flatter ridgetops. Such land is largely given up to pasturage. These soils are shallow and rocky and of the DeKalb series designated as loams and rough, stony land.

The wooded areas in the agricultural section consist of mixed second-growth hardwoods, either in small woodlots or in larger and more continuous bodies along steep valley slopes and toward the headwaters. In the woodlots the humus is good, but is only fair on the larger bodies of woodland. The principal species are the oaks, beech, maple, basswood, black gum, chestnut, hickory and walnut, with a very little yellow poplar and scattered hemlock. Beech often forms an understory.

Above Buckhannon, the areas of woodland become larger as the forested region at the headwaters is approached. Lumbering has been more recent, and the stands are in poorer condition. Remnants of a former good stand of yellow poplar are found, and hemlock occurs in small pure groups in the valleys. Much of the woodland which has been culled for timber is now being stripped for chemical wood.

Lumbering operations at Pickens and other points have about exhausted the merchantable timber on the Buckhannon watershed, and are now drawing their supplies from the Kanawha side of the divide. There are coal mines on Left Fork, which heads in the Rich Mountains, and logging and mining railroads extend up many of the headwater streams.

Fires have burned over limited areas, and have destroyed the humus. Except where chemical wood has been cut or where lumbering has been recent, however, the density and humus conditions are, on the whole, very fair. This region was formerly covered with fine stands of yellow poplar, oak, chestnut, beech, maple and hemlock, but lumbering has reduced the proportion of better species of trees and reproduction is now largely of the more resistant and poorer ones.

Middle Fork. Middle Fork drains the western part of Randolph County, and flows north approximately parallel to, and east of, Buckhannon River, its right fork heading in a minor divide which separates Middle Fork from Buckhannon waters, and its left fork rising on the western slope of the Rich Mountains, the westernmost of the distinct mountain ranges, known farther north as the Laurel Hills. Sandstones form the mass of rock outcrops on the ridges. Limestone also outcrops near the stream levels on the high plateaus. Quite extensive agricultural areas occupy the right fork, and the lower course of Middle Fork itself. The left fork is cleared in places, but its headwaters on Rich Mountain are uniformly wooded. One of the largest bodies of virgin spruce, hemlock and yellow poplar on the Monongahela watershed is at the head of these forks. The streams flow through rocky, gorge-like valleys; they carry no sediment and there is no indication of erosion.

Headwaters of the Tygart. The headwaters of the Tygart is commonly known as the Valley River. It drains an area lying, for the most part, between the Rich Mountains on the west and the Cheat Mountains on the east, and extending in a long, proportionately narrow basin through the entire length of Randolph County, from the northern edge of Pocahontas County. The source of the river is in the broad tablelands which form the divide between the Monongahela and Kanawha watersheds at elevations of somewhat over 3,000 feet. The topography at the headwaters is not abrupt. It is rather an elevated and rolling plateau, with knobs of slightly higher elevation. The

topography becomes more irregular and the slopes steeper in the lower stream valley. Limestone is an important formation on the high tableland, and occupies large areas at the heads of the streams. Lower down, the limestone outcrops on the steep upper slopes of the bordering ridges. Sandstone is the prevailing rock formation on the ridges.

Nearly the entire length of Valley River, from its head to central Randolph County, where the stream cuts through the Rich Mountains, is extensively cultivated; the valley broadens and becomes almost entirely cleared between Huttonsville and Elkins. Above Huttonsville, the cleared areas are frequent, but not continuous. The lower valley floor is broad and flat and the soils are rich clays and loams, which are cultivated or in grass. The bordering mountain ranges are steep and rocky, and entirely wooded above the pastures. At Elkins, Leading Creek from the north joins Valley River, which turns west at this point, and after cutting a gorge-like course through the range, again flows north along the west slope of the range and with Middle Fork and Buckhannon River forms the lower Tygart Valley River. Cleared areas occur where the valley widens at junctions with other streams, and back from the bordering slopes.

There is no suggestion of serious erosion anywhere on the Valley River watershed. The waters, though more or less swift, flow from rocky, wooded slopes, and the valley is either flat and with wide bottoms, or where it cuts through the steep ranges, extremely rocky. The water is clear, and injurious effects of overflow are not apparent.

The slopes are too steep and rocky for cultivation or pasturage and are almost entirely in forest growth. Except at the headwaters, they have already been largely culled of the best timber. Unfortunately, fires have burned over most of these areas, and the humus is thin, especially on south slopes, and reproduction is of no great value. The growth on the cut-over south slopes is largely oak, while mixed beech, maple, birch, oak and hemlock are found on the colder north slopes. Humus conditions on the latter type are much better. The surface is more or less broken and porous, so that run-off is not excessive.

The greater part of the valuable virgin timber on the watershed has been cut by band mills in the main valley. The headwaters, especially on the west slope of the Cheat Mountains, still contain splendid stands of yellow poplar, basswood, hemlock, oak and cherry in small lots along the creeks and at the heads of the ravines on limestone soil, and some spruce and hemlock on the higher slopes. The yellow poplar in mixture often averages 3,000 feet per acre. Spruce is not found to any extent below an elevation of 2,700 feet.

Elk Water River and Mill Creek basins have been mostly cut over, save for small lots of virgin timber, but they are uniformly wooded with chestnut, red and white oak, beech, poplar, maple pitch pine and scattered hemlock. Some of the best spruce, hemlock and yellow poplar timber in West Virginia is located on the adjoining watershed to the west, and is being logged from Mill Creek. On the east side of the Rich Mountains the timber is mostly exhausted. A standard gauge logging railroad extends up Mill Creek, and a narrow gauge line up the Valley River. Where the more extensive bodies of timber have become exhausted, small lots owned by farmers are now being cut over. Wooded areas in this watershed and west of it are owned by farmers to a greater extent than on the continuously wooded watershed to the east. A dozen portable mills are now cutting oak, beech, maple, chestnut, poplar and hemlock for furniture stock, car sills, ox yokes, railroad ties and other miscellaneous purposes from lands formerly logged for spruce, hemlock and poplar. Yellow poplar, spruce and basswood are being extensively cut for pulpwood, and shipped to mills in other regions. The completion of this cutting means the exhaustion of the timber supply for many years, but there is sufficient density in the sapling and pole trees to maintain a good forest cover.

Shavers Fork of Cheat River. Shavers Fork, which joins Dry Fork at Parsons in Tucker County, West Virginia, to form the Cheat River, is a stream of considerable length and without any important tributary. It rises in the Back Allegheny Mountain range, the southern extension of Shavers Mountains in Pocahontas County, and flows north between the Shavers and Cheat ranges through Randolph County, and a part of Tucker County. The drainage area is not wide or particularly important commercially, since the stream flows through a steep, gorge-like valley between high mountain ranges too rough and inaccessible for agricultural development. There are no bottom lands, except as the valley widens toward Parsons. The headwaters lie at an elevation of between 4,000 and 4,500 feet in a nearly uniform plateau forming the divide between the Monongahela and the Greenbrier watersheds. Occasional knobs rise to elevations of over 4,500 feet. The importance of this region from the standpoint of watershed protection may be judged by the fact that in addition to the Monongahela drainage, the Potomac, James, Greenbrier and Kanawha rivers have their headwaters in a comparatively restricted portion of this elevated plateau. Shavers Fork flows north to the rim of the plateau, and then cuts its way rapidly into the valley between slopes which become steeper and rela-

tively higher as the valley reaches successively lower elevations. In its lower course the ranges become less distinct, and the river cuts through the Cheat Mountains and flows to Parsons through a country extremely rough but lower in elevation.

The high plateau at the headwaters is composed of limestone and sandstone, the former occupying extensive areas on the summits of knobs and on high flat areas. This is particularly noticeable on the watershed of Dry Fork to the east of Shavers Fork, where many of these areas are cleared. Lower down, sandstone is dominant, and outcrops of limestone occur on the steep upper slopes of the ranges.

The watershed of Shavers Fork more nearly represents virgin conditions than any other in the entire Monongahela and Allegheny drainage basins. There is less marked variation in the flow of water, and through its long, rocky course, the stream carries no appreciable amount of sediment. The few cleared areas are located on limestone soils on the flat-topped ridges above the fork, or on the lower bottoms toward the junction with Dry Fork.

The watershed is almost entirely wooded, and the higher elevations are in a large measure still in virgin spruce and hemlock. The forests are cut over along the river, from Parsons to Bemis, a sawmill town on the Western Maryland Railroad, about half way to the head of the fork. About this point, for about 15 miles, along the roughest portion of the fork, a heavy forest of spruce and hemlock still remains, extending on either side to the tops of the mountain ranges. On the headwaters above this virgin timber, logging operations have been carried on for many years from the Greenbrier side of the divide, and the best timber has been removed. These operations will soon extend down the fork to this remaining body of timber. Other large bodies of spruce and hemlock are found on the upper slopes of the Shavers Mountains farther north, but they lie largely on the eastern slope on the watershed of Dry Fork. Aside from these large bodies of coniferous forests, Shavers Fork has been almost entirely cut over, in many places only lightly, but on some steep, recently-lumbered slopes along the railroad, only brush and slash remain. The general conditions of the cut-over lands on this watershed are much better than the average. Excellent stands of second-growth hardwoods are found along parts of the lower course, and some hardwood stands have been so lightly culled that they differ only slightly from the original growth.

Spruce is found at the highest elevations, excepet on a few bald, rocky knobs. It is more or less mixed with hemlock, particularly at the lower limits of its altitudinal range. The present commercial stands of spruce are above 3,000 feet. Below this elevation, the growth is mixed hardwoods and hemlock, mostly birch, maple, beech, cherry, basswood, ash, hickory, yellow poplar, chestnut and the various species of oaks. Beech often occurs in nearly pure stands. Hemlock forms a general mixture, but is most abundant on north slopes, in the coves, and at higher elevations with spruce. Basswood is found with hardwoods at higher elevations, while yellow poplar grows in mixture in moist coves and at the heads of streams on good soil. The oaks are most abundant at the lowest elevations on dry slopes and ridge tops.

On the cut-over hardwood lands, birch, maple, beech and oak form the greater part of the second growth. The oak may be in nearly pure stands of scrubby growth, but where fires have not been excessive, the undergrowth is dense, with rhododendron forming a conspicuous part of it.

The watershed has been fairly free from destructive fires. Along the Western Maryland Railroad, which crosses the Cheat and Shavers ranges, the slopes have been burned to some extent, and fires have occurred on limited areas away from the railroad in the Shavers Mountains. Humus conditions are poor on the steep, cut-over slopes where the oak type prevails. In other situations undisturbed by fire, particularly under spruce and hemlock stands, it is deep and moist. The broken, rocky character of the wooded slopes helps to retain the soil as well as the moisture.

There are at least six large band sawmills operating in this watershed, besides many smaller mills. Other mills have been abandoned within the last few years. Probably the lumber industry is now at its maximum development, and within the next ten years all but one or two of the larger concerns will have cut over their holdings. Portable mills will then continue to operate on cut-over land and in scattered lots which are left.

Natural reforestation will take place over most of this watershed if fires are kept out. The hardwoods will, of course, increase in spruce and hemlock areas, since a reproduction of the latter species is slow and uncertain. The owner of the largest spruce holdings in the entire region has begun to reforest the cut-over lands with wild spruce seedlings.

Dry Fork of Cheat River. Dry Fork and its tributaries, Gandy, Laurel and Glady forks, form a series of parallel valleys, separated by ridges of a very mountainous nature, and drain an area rich in virgin timber. Gandy Creek is the commonly accepted name of the Dry Fork headwaters. Starting

in the plateau at the southern boundary of Randolph County, these streams flow north and unite to form the main course of Dry Fork, which then flows northwest and joins Shavers Fork at Parsons. Dry Fork also drains the country to the east and northeast through Red Creek, and at Hendricks receives the waters of Blackwater River, which drains south from the Canaan Mountains. All this region is rough and mountainous, with narrow, steep-sided valleys. While some of the wider ridges have considerable areas of high, level plateau land, many of the valleys are so close together that the intervening ridges are very narrow and broken The general elevation of the parallel ridge-tops is about 3,500 feet. Limestone caps these ridges in the extreme south, and gives rise to the "sinks" country, a section which is largely cleared for grazing and has also some good farms. Farther north, at Davis, there is a large amount of cleared and waste land, and the Canaan Valley is also cleared and in farms. A large natural savanna at the head of Blackwater River is an unusual feature of the watershed. There is no erosion, and the streams run clear in the rocky valleys.

Agriculture is still in the sawmill stage; that is, it depends largely on the lumber business for its market, and the farmers find employment in the lumber operations at odd times. For many years, however, this region has been important from a grazing standpoint. Cattle owners burned and destroyed the timber over large areas on the limestone ridges, and drove their cattle up from the valleys of Virginia to graze on the fine natural bluegrass. Grazing shares with lumbering the blame for many of the destructive fires, and is more culpable, since it made no use of the valuable stands of timber thus destroyed in creating pasture land. The forests originally contained some of the best spruce of the country. Hemlock was also abundant, while beech, birch, maple and cherry, as well as oak and chestnut, were the predominating hardwoods. The present forest consists mainly of two types, virgin spruce and hemlock, and second-growth hardwoods with scattered hemlock and spruce. While some of the second-growth stands are dense and vigorous, the greater part of them are fire-damaged and consist of open or scrubby trees, with occasional areas of fire cherry. The virgin stands are located largely on Laurel Fork above the Rich Mountain, on Glady Fork, on a section east of the Blackwater River, and on the headwaters of Red Creek. Hardwood stands in the Canaan Mountain section and at the head of Otter Creek, where the best trees were cut out many years ago, have since recovered almost their original density. There are areas of good second-growth hardwoods on the headwaters of the Blackwater and south to the head of Red Creek.

The north end of Dry Fork has been largely cleared for pasture, especially on the bordering ridges. Gandy Fork, above Horton, has been quite recently lumbered, and large areas are burned and only growing up to scrubby beech and oak. The lower part of Laurel Fork is in much the same condition. The plateau to the east and west of the Blackwater River, except the areas of virgin timber, has recently been very severely cut over and burned and is now a rocky waste.

Fires to promote grazing are less prevalent as the cattlemen come to realize that they do more harm than good. The slash from spruce lumbering is, however, very heavy and the lumbermen claim that fires on cut-over land cannot be prevented, and content themselves with protecting their merchantable timber. Humus conditions vary from the thick covering under the virgin spruce to the absolute lack of cover on the rocky, waste areas. The land is practically all held in very large tracts by the various lumber companies.

Lower Cheat River. From the junction of Shavers and Dry Forks, the Cheat River flows northwest through Tucker, Preston and northeastern Monongalia counties, and joins the Monongahela River at Point Marion, a short distance north of the state line in Fayette County, Pennsylvania. The course of the Cheat from Parsons to St. George is through a wide, flat-bottomed valley, below which the slopes are higher and steeper, and the bottom lands become fewer and widely separated. In northern Preston County the valley deepens, the slopes rise precipitously, and until within fourteen miles of the Monongahela River, the Cheat passes through a wild and inaccessible gorge, in places from 1,000 to 1,200 feet deep. The bordering country is drained by a large number of tributary streams, especially east of the Cheat valley, and the original plateau has been deeply dissected. Approaching the mouth of the Cheat, the country becomes smoother and largely agricultural. In the bottoms north of Kingwood, and back from the precipitous slopes of the streams, the country is also extensively cleared and in cultivation.

The forested areas occupy more than half of the watershed. The slopes of the creeks, as well as the gorge along the Cheat River and the thin-soiled areas on the ridges and plateau, are well wooded and should remain so. There is still much virgin timber at the heads of runs and on slopes difficult to log. Areas within reach of floatable streams were long ago culled of the best and biggest trees among the species that could be floated easily. The timber left has in places so nearly regained its original

Slopes where vegetation is practically absent because of fumes from the coke ovens.

Waste areas in the coal region of southwestern Pennsylvania. Shows the surface caving in where ridges have been tunneled for coal.

density and general state of maturity that for all practical purposes it can be classed as virgin hardwoods. Even in stands which are essentially second-growth, there are often found many mature trees which, under the better prevailing market conditions, may be considered merchantable. Where more recent operations have been carried on, using logging railroads for transportation, the land has been completely cut over and only young second-growth is present.

The largest bodies of virgin timber are on Horseshoe Run, Wolf Run, Roaring Creek, Big Muddy Creek, the Sandy Creek system, the extreme head of Laurel Creek, and from the mouth of Muddy Creek along the entire length of the Cheat River gorge. The principal species are the oaks, chestnut, beech, birch, maple, hickory, yellow poplar and hemlock. There is a little spruce in the southern part of the watershed, and the remaining virgin timber is being rapidly lumbered. In the northern part, much of the timber in the more inaccessible places will remain until the stumpage values increase so as to make the lumbering of it profitable.

On the whole, burned areas are uncommon and small in extent, and the humus conditions are fair throughout the watershed.

Lower Monongahela. The lower course of the Monongahela, through Monongalia County, West Virginia, and the southwestern counties of Pennsylvania to Pittsburgh, is in a rolling country, with gentle slopes and meandering streams. The present topography is the result of base leveling, followed by uplift and the wearing down of the stream valleys. The main course of the Monongahela is peculiarly irregular and meandering, and in many places old channels have been abandoned. The river flows gently, and by means of lock dams is navigable to Fairmont, West Virginia. The banks are usually steep, back of which the slopes rise gently to the rolling divides. Numerous tributary streams join the Monongahela from the east and west. The underlying rock formations are shales, sandstone and thin beds of limestone. Coal occurs throughout the region. Rock outcrops are not conspicuous, and fairly deep, fertile soils have been developed.

The entire country is practically cleared. The wooded and brush areas are most extensive on the steeper slopes along the streams, decreasing toward the north. The influences of the City of Pittsburgh embrace this country for at least 12 miles, and in this distance there are few wooded areas large enough to show on the map.

In a region of this size, with the land largely cleared, the agricultural and grazing value in the aggregate is large. Probably less than 25 per cent, however, is well cultivated, the remainder being in pasture or in waste. Large portions of Washington and Greene counties are devoted to stock raising, with two-thirds to three-quarters of the land in grass. Farther north, toward the junction of the Monongahela and the Youghiogheny, where the topography is less abrupt, and the proportion of limestone is greater, agriculture is more highly developed. The general conditions do not differ materially from those described for the region along the lower Youghiogheny River.

Erosion of steep farm lands, especially on red shale soils, and gullying along streams and highways, while not extensive, are frequent. The streams are also carrying away their banks in places. A grass cover forms quite easily and arrests erosion which might otherwise become more disastrous. The hard clay surface of the hills and slopes, though well sodded, does not check the rapid run-off of water. The streams are low in summer but rise rapidly during seasons of freshets.

In the few scattered woodlots and brushy areas the various species of oak predominate. Sycamore and black walnut are found along streams, with elm, hickory, yellow poplar, ash, cherry and locust in mixture. Locust is common both in mixture with other hardwoods and in pure stands on abandoned land. White pine and chestnut are rarely found. Humus conditions are generally poor.

PART III—SOME FACTS ABOUT FORESTS AND STREAM-FLOW.

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INTRODUCTION.

The factors which influence the flow of water in streams have received a great deal of attention from engineers, meteorologists and foresters in Europe and in this country. Yet there still exists a difference of opinion as to the importance of several factors affecting stream-flow, especially that of forest cover.

Lack of Accurate Data. The difficulty of arriving at definite conclusions lies in the complexity of the problem and in the fact that, with the exception of a carefully planned experiment carried on for about ten years by the Swiss government and a similar experiment started in the Rocky Mountains by the Forest Service in coöperation with the Weather Bureau, there have been no thoroughly accurate studies of this problem. This was clearly demonstrated at the International Congress of Hydrographic Engineers at Milan in 1905, when a resolution was proposed to establish an international bureau for collecting and correlating data on the relation of forests to stream-flow, so as to arrive finally at some conclusion in regard to this important subject. At present accurate data of this character do not exist.

Deductions have often been made from deficient data secured in a limited region, and applied in general to all rivers, all climates and conditions. The drainage basins have been, as a rule, extremely large, often thousands of square miles in extent, on which many counteracting factors obscure the true relation of forest cover to stream flow. In the majority of cases either stream measurements, or rainfall data, or both, were deficient, and only in very few cases can one find measurements of stream-flow and rainfall for the same period and the same watershed.

Measurements of the stream-flow itself have not, as a rule, been uniform during the entire period of observation. Most of the measurements have been merely of the height of the water, and have failed to take into account the rapidity of the flow. Many of the stream gauges have been located in the lower reaches of large rivers, and, therefore, could not yield reliable results, since the flow of water in the lower reaches of a river is the result of conditions prevailing on all of its various tributaries.

In very few of the American investigations have exact records of the condition of the cover of the catchment basins been made, though in some cases the changes in the cover are roughly referred to for the period under investigation. Mere reference, however, to the fact that lumbering has been carried on on a given watershed, while on others no logging has been done, is not a sufficient indication that the beneficial influence of the forest cover has been impaired in the former case, nor that the conditions on the latter are necessarily favorable to stream-flow. On the contrary, a logged-over area may contain young reproduction, the effect of which upon the run-off may be just as favorable as intact virgin forest. Furthermore, a mature forest, if repeatedly burned or grazed, and thus deprived of its leaf litter, may cease to exercise its normal beneficial function upon the surface run-off.

For these reasons it is obvious that all deductions made from such general observations must be accepted with caution until the results of the more intensive and thorough studies now being carried on by the Swiss government and by the United States become available. If, however, direct observations of the flow of water in streams have not yielded convincing results, careful and thorough studies, performed in many countries and extended over long periods, of the influence of the forest upon each of the several factors affecting the water supply in rivers, have furnished conclusive proof that forests do have a most important effect upon stream-flow.

INFLUENCE OF FORESTS UPON STREAM-FLOW.

The facts which have been established relative to the influence of forests upon stream-flow may be briefly summarized as follows:

1. The forests lowers the temperature of the air inside and above the forest, thus inducing the

condensation of vapor over the forest, and in this way perceptibly increases local precipitation (dew, mist, rain, snow).

French observations are practically unanimous in recording a larger amount of precipitation over forests than outside of them. Regular observations taken at Nancy for 33 years, since 1866, at stations inside, on the edge of, and outside the forest show that without exception more rain fell inside than outside the forest, and that in 8 out of 10 cases more rain fell at the edge of the forest than outside. If the amount of the rainfall at the center of the forest be designated as 100, then the amount of rainfall at the edge of the forest would be represented by 93.9 and the rainfall outside the forest by 76.7.

2. The forest cover, more than any other vegetative cover, intercepts atmospheric precipitation and prevents it from reaching the ground. The amount of precipitation thus lost, however, is offset, except in dense, old stands of pure spruce, by the greater precipitation over the forest and the greater condensation of vapor within the forest in the form of dew, hoar-frost, etc.

As a result of a great number of investigations, it is safe to assume that coniferous forests retain more precipitation than broadleaf forests. Under average conditions, a spruce forest will intercept about 39 per cent of precipitation, a broadleaf forest about 13 per cent. In a young stand the amount of precipitation intercepted is the least, in middle-aged stands it is the most.

In regions where the precipitation is in the form of heavy or prolonged rains, the ground under the forest, no matter whether the latter is deciduous or coniferous, will be wet as much, or nearly as much, as the bare ground, while in regions where the rains are neither heavy nor of long duration, a large portion of the precipitation will remain in the tree crowns and escape the soil. That portion of precipitaion which is prevented from reaching the ground directly is not lost, however, for the forest. Its evaporation increases the relative humidity of the air, which, together with the lower temperature within the forest, helps to condense, especially in coniferous forests, a great deal of moisture from the vapor-ladened air which passes through them, in the form of fog, dew, and hoar-frost.

3. The summer temperature of the air and soil in the forest is lower, the relative humidity of the air is greater, the movement of the air is less in the forest than outside of it. This, together with the double protection afforded to the soil by the mulch of fallen leaves and humus and the tree tops, tends to reduce the direct evaporation from the soil in the forest to practically a negligible quantity as compared to that in the open.

Careful observations extending over a long period in France, Germany, Austria, Switzerland, and other countries, have established the fact that forests reduce the temperature of the air: First, by preventing the heating of the soil by the sun; second, by transpiring water from the leaves—this process of transforming water into vapor absorbing heat and, therefore, reducing the temperature of the surrounding air. The yearly mean temperature at equal elevations and in the same locality has invariably been found to be less inside than outside a forest. The difference between the yearly mean temperature inside and outside of a forest is about 0.9 deg. F. for forests in a level country. This difference increases with altitude, and at an elevation of about 3,000 feet it is 1.8 deg. F.

The forest soil is warmer in winter, 1.8 deg. F., and is cooler in summer, from 5.4 to 9 deg. F., than the soil without a forest cover, and this holds true for depths as low as 4 feet. In the spring the forest soil is cooler than that of open land, and this continues throughout the summer, when the difference is at its maximum.

The relative humidity of the forest air has been found to be between 9 and 12 per cent higher than that in the open, and is higher in summer: First, because the transpiration of water by the leaves appreciably increases the moisture content of the air within or near the forest; second, because the temperature of the air is lower in the forest, and, therefore, the air is nearer its saturation point.

Observations carried on by the Forest Service in the study of the influence of wind-breaks upon crops have shown that the per cent of moisture saved from evaporation, within an area 12 times as wide as the height of the trees at different wind velocities, may amount to from 11 to over 40 per cent. Experiments conducted by Prof. Ebermayer for five years (1869-1873), in Bavaria, have demonstrated that a layer of fallen leaves is capable of reducing evaporation from the soil 24 per cent. Thus, while the average evaporation from the soil deprived of leaf litter in the forest, during the summer months, (May to September), amounted to 39 per cent of that in the open, the evaporation from the same soil covered with a fairly deep layer of leaf litter was only 15 per cent of that in the open. In other words, while the forest cover alone diminished the evaporation from the ground by 61 per cent, the forest cover, together with the leaf litter, reduced it by 85 per cent, making it only 15 per cent of that in the open.

4. In level country, where there is no surface run-off, forests act as drainers of the soil; hence their importance in draining marshy land and in improving hygienic conditions. In such country their effect upon springs is unimportant.

The afforestation of the swamp lands of southern France, the Landes, with maritime pine brought about a lowering of the water table. In Italy, the water table in swamps has been lowered by planting eucalyptus, and in many swampy regions in Europe, where, before afforestation, the drainage ditches were always full of water, after planting, they became entirely dry.

5. In hilly and mountainous country, forests, irrespective of species, are conservers of water for stream-flow. They increase the underground storage of water to a larger extent than do bare surfaces or any other vegetative cover. This effect is the greater the steeper the slope, the less permeable the soil, and the heavier the precipitation.

A German investigator of high standing (Ney) places the amount of water which the forest cover *saves* to the soil by reducing the surface run-off and changing it to underground seepage, for forests at lower altitudes where the rains are not heavy and the soil is less subject to freezing, at 20 per cent; for forests of moderate altitude, at 35 per cent; and in mountain forests, at 50 per cent of the precipitation. Measurements of the surface run-off, carried on by Jeandel Contequil and Ballaud in the Vosges Mountains in France, have shown that the surface run-off from wooded slopes is nearly two times less than that from deforested slopes, while the underground seepage is greater and the flow of the streams more regular than from the deforested slopes.

Such an authority as Huffel states that under ordinary conditions of rainfall there is practically no surface run-off from wooded watersheds having an abundant leaf litter. The forest in the mountains, therefore, even on the steepest slopes, has the effect of creating conditions with regard to surface run-off such as obtain in a level country.

6. Forests retard the melting of snow and thus provide for the gradual feeding of mountain streams.

The influence of forests in retarding the melting of snow has been demonstrated with especial precision in a ten years' series of observations carried on at the Imperial Agronomic Institute at Moscow. These observations show that the period of snow melting lasts within the forests from 26 (1904) to 57 (1902) days, while the snow in the open situations disappears within six or seven days. Thus, in 1908, the melting of snow, which began April 12, lasted in the forest until May 15, (34 days), but in the fields, pastures, and all other open places surrounding the Institute, only until April 22, (11 days), while in the more exposed fields the snow had all disappeared as early as April 18, seven days after the commencement of melting. The retention of snow in the forest until May 15 was in spite of the fact that after April 22 there were frequent warm rains.

Forests have not only a very decided influence in retarding the melting of snow in general, but there is also a close relation between the melting of snow and the species, density, age and location of the forest. In large forest areas composed of different types, a definite consecutive order in the progress of melting has been demonstrated, and this order, which depends entirely upon the character of the forest cover, has been found to hold true from year to year, irrespective of the weather at the time of the melting. The snow disappears first of all from the clearings in the forest, simultaneously with its disappearance from open fields. Next it disappears from young forest plantations, in which the tree tops have not yet begun to touch each other. Next come thin oak forests, growing on southerly slopes, and old, open, pine forests. Then the snow begins to disappear on northerly slopes in dense stands of birch, later in pine, and last of all, in spruce forests. Thus, in 1908, the ground in a certain locality became entirely free of snow on the following dates:

On fields, clearings, and open places	April 22
In young, still open stands	April 24
In old, open stands on south slopes	April 26
In birch stands	April 29
In pine stands	May 6
In spruce stands	May 15

7. By preventing surface run-off, the forest, more than any other vegetative cover, protects the surface soil from erosion and thus reduces the amount of sediment carried by streams.

Wherever the topography is at all rough, the destructive activity of running water in washing away the soil becomes important. Erosion and the washing away of the soil depend upon the steepness of the ground, the character of the soil, and the geological formation of the region. When the slopes are steep and the soils and the underlying rock are friable, the erosion by surface run-off reaches colossal proportions.

Erosion has also a bearing on the height of flood water in the streams, since the sediment carried by the rivers and the coarser detritus in the mountain streams increases stream volume to such an extent, in many cases, as to raise the height of the water far beyond the points it would reach if it came free of detritus and sediment from forested watersheds. How great may be the volume of detritus carried by a given volume of water is clearly brought out by Demontzey, who computed that one mountain torrent brought down in 85,020 cubic yards of water, 221,052 cubic yards of detritus, or more than two and a half times its own volume.

In mountainous regions where a thin soil covered with forest is underlaid with hard rock, such as, for instance, limestone, or in fertile formations, such as chalk, destruction of the forest may often result in the complete desolation of the region. As long as the soil which was formed during centuries by the disintegration of the rock and the accumulation of humus is held together by the roots of trees, some ground waters may accumulate within them, or even small springs may be formed. Karst, portions of Greece, Palestine, and the mountainous provinces of southern France and Italy are classical examples of the evils of forest destruction and subsequent erosion.

8. In the mountains, the forests, by breaking the violence of rain, retarding the melting of snow, increasing the absorptive capacity of the soil cover, preventing erosion and checking surface run-off in general, tend to equalize the high and low stages of streams and to maintain a steady flow of water in them.

The capacity of the forest soil to change surface run-off into underground seepage is one of the most important factors in regulating stream-flow. Prof. Henry, of the Forest School at Nancy, France, conducted a series of experiments with typical soils from spruce and beech forests. Taking the greatest care to preserve the natural arrangement and solidity of the soil, a number of samples were removed, thoroughly saturated by plunging in water for several days, drained of the excess moisture, and weighed. After thoroughly drying the samples at a temperature of 100 deg. C. (212 deg. F.) they were reweighed, and the weight of water held by the saturated soil thus determined. From the average of all the weighings it was found that the spruce needle humus, dried at 100 deg. C., contained, when saturated, 4.15 times its own weight in water, while the beech leaf humus contained 5.38 times its own weight. When simply air-dried, which is, of course, the limit to which it proceeds in nature, beech leaf humus was found still to absorb 4.41 times its weight, while air-dried spruce humus took up about 3.38 times its weight.

To ascertain the actual amount of water absorbed and retained per given unit of area by spruce and beech humus, the average weight of oven-dried (100 C.) humus per two and a half acres was determined. Allowing 15 per cent for excess moisture content of air-dried over oven-dried humus, the air-dried beech and spruce types of humus were found to have a retentive capacity in English units of approximately 46.44 and 22.2 tons of water per acre, respectively. This amounts in volume to 1,510 cubic feet for beech and 712 cubic feet for spruce humus, and is equivalent to a rainfall of 0.41 inch and 0.2 inch respectively.

Huffel found that a forest with soil covered with leaf litter, even on the steepest slopes after a rainfall of from 2.4 to 2.8 inches, does not give off a drop of water in the form of surface run-off.

9. By stimulating the absorption of water by the soil, forests act as a filter in purifying the water supply.

Such in brief are the scientific facts relative to the influence of forests upon stream-flow. While this influence exists wherever forests exist, there is considerable variation in the degree in accordance with the climatic conditions. The forest exerts a less marked influence in regions of high humidity, gentle topography, light summer rains and abundant snow than it does when the topography is more broken, the evaporative factor high and the rainfall concentrated and intermittent. Its influence increases with the increase in the aridity of climate and irregularity of rainfall. Its efficacy, however, is at a maximum in a region of heavy, intermittent rainfall, where the humus is most efficacious in promoting absorption, and the protective cover in lessening erosion.

APPENDIX No. 2.

PRECIPITATION.

Causes and Sources of Precipitation—Uses of Data—Rainfall Stations—Annual Rainfall—Seasonal Distribution — Maximum Daily Rainfall—Snowfall—Rainfall Tables.

INTRODUCTION.

Causes. Precipitation may take place in the form of rain, snow or sleet. It is caused by the condensation of the moisture in the atmosphere when warm, moisture-laden vapors come in contact with cooler air-currents. Warm air is capable of absorbing more moisture than is cool air, and consequently, when warm air is saturated, any sudden drop in temperature results in the precipitation of the excess moisture, which can no longer be held by the cooled air. The amount of this precipitation is usually expressed in inches of depth over the surface.

Sources. Over the region east of the Allegheny Mountains, the precipitation comes largely from the Atlantic Ocean; but much of the rain falling on the basins of the Allegheny and Monongahela Rivers presumably comes from the Gulf of Mexico, while in the extreme northern portion, some of the precipitation may result from proximity to the Great Lakes.

Uses of Data. A thorough knowledge of the distribution, the amount and the fluctuation of precipitation over the Allegheny and Monongahela Basins is indispensable in a study of the regimen of the main rivers and their tributaries, and of their relation to floods at Pittsburgh and further down the Ohio. A comparison of rainfall and stream-flow data shows the per cent of rainfall running off, and in cases where stream-flow data are not available, enables such run-off to be estimated from rainfall records. Such a comparison is made in Appendix No. 3, under stream-flow, and affords a basis for a study of the effect upon run-off of the character of the various drainage areas for which data are available, particularly as regards size, shape, topography, geology, forest cover, etc.

Such information has been essential in the studies of this Commission relating to the control of floods by storage reservoirs, in order to investigate the effect of storage upon flood heights, to select the most effective reservoir projects, and to determine their necessary capacity. If a system of reservoirs were constructed, moreover, the fullest information regarding rainfall would be needed to operate the system effectively for flood control and for the improvement of the low-water flow for navigation and other purposes.

RAINFALL STATIONS.

By careful research, the Flood Commission has obtained the records of 84 rainfall stations scattered over the Allegheny and Monongahela Basins, all of which are operated under the direction of the United States Weather Bureau. Of these, the records at one station, Pittsburgh, cover 68 years; at 13 other stations, 25 years or over; at 15 stations, 20 to 25 years; at 21 stations, 15 to 20 years; at 9 stations, 10 to 15 years; at 21 stations, 5 to 10 years; and at 4 stations, less than 5 years.

ANNUAL RAINFALL.

Isohydral Map. From these data was constructed the isohydral map, Plate 91, showing the mean annual rainfall on the Allegheny and Monongahela Basins. In interpolating the lines of equal rainfall, the same weight has been given to the mean annual rainfall at each station, irrespective of the term of the record. While at a later date, when records are extended, there might be minor changes in these lines at points influenced by short-term records, it is felt that they are reasonably accurate, and furnish a satisfactory graphical representation of the distribution of mean annual rainfall over the two basins.

In order to determine the mean annual rainfall for each basin, the areas between the isohydrals were measured with a planimeter and multiplied by the corresponding average rainfall, as represented by the average of the two isohydrals bounding the respective areas. The sum of these products for each basin was then divided by the area of the basin, and the result taken as the mean annual rainfall for the basin. The figures obtained show the Allegheny Basin to have a mean annual rainfall of 42.4 inches, and the Monongahela Basin, of 45.5 inches.

Distribution. The lowest mean annual rainfall on the Allegheny Basin, 37 to 39 inches, is in the extreme northern portion, near Lake Erie. From here it increases southwardly to 46.4 inches at Clarion, on the Clarion River. At Johnstown, on the Conemaugh, in the southern part of the basin, the average is 45.1 inches, increasing further up this stream to an average of 48 inches near the source. The greatest mean annual rainfall recorded at any station on the Allegheny Basin is at Clarion, 46.46 inches, or 4.06 inches above the average for the basin; the lowest is at Pittsburgh, 36.1 inches, or 6.3 inches below the average for the basin; giving a difference of 10.36 inches between the greatest and least mean annual rainfall on the basin.

The Clarion and Kiskiminetas Basins receive a greater rainfall than those of any other tributaries of the Allegheny River. The Clarion has a mean annual rainfall of about 43 inches at the mouth, increasing to 46.46 inches at Clarion, and then falling to about 38 inches at the source. The Kiskiminetas has a mean annual rainfall of about 42.2 inches at the mouth, decreasing to 38.7 inches at Saltsburg, and then increasing to about 48 inches at the source.

The region of lowest rainfall on the Monongahela Basin is along the lower reaches of the valley, the minimum mean annual precipitation, 39.2 inches, being at Lock No. 4, Pa. The greatest mean annual rainfall occurs along the Allegheny Mountain ridges in West Virginia, the average at Pickens being 55.5 inches and at Terra Alta 57.9 inches. This is doubtless due to the fact that the low-lying clouds traveling from the south and southeast deposit their moisture on reaching these high points. In years of heavy rainfall, the annual precipitation is considerably greater than the above figures, the maximum recorded at Pickens being 80.9 inches, in 1907, and at Terra Alta, 75.5 inches, also in 1907.

The mean annual rainfall at Terra Alta, 57.9 inches, is the greatest recorded at any station on the Monongahela Basin, being 12.4 inches above the average for the basin. The lowest mean annual rainfall on the basin is at Lock No. 4, 39.2 inches, or 6.3 inches below the average for the basin; so that there is a difference of 18.7 inches between the greatest and least mean annual rainfall on the basin.

The Cheat and Youghiogheny Basins receive a greater rainfall than those of any other tributaries of the Monongahela. The Youghiogheny has a mean annual rainfall

of 38 inches at the mouth, which increases to about 48 inches at the source. The Cheat has a rainfall of 43 inches at its mouth, which increases to 57.9 inches at Terra Alta, dropping to 45 inches at Parsons and increasing again to 55 inches at its source.

The minimum annual rainfall recorded on the Allegheny Basin occurred in 1887, at Saltsburg, Pa., when the total precipitation for the year was only 22.3 inches, or 16.4 inches below the mean annual rainfall at that station. The maximum annual rainfall occurred in 1870, at Franklin, Pa., when the total precipitation for the year was 59.7 inches, or 18.8 inches above the mean at that station.

The minimum annual rainfall on the two basins is recorded for 1886, at Rowlesburg, W. Va., and amounted to only 19.1 inches. It is interesting to note the wide range in the annual rainfall at this station, where the variation is the greatest of any of the stations studied, the maximum of 72.1 inches, in 1907, being nearly four times the above minimum.

SEASONAL DISTRIBUTION.

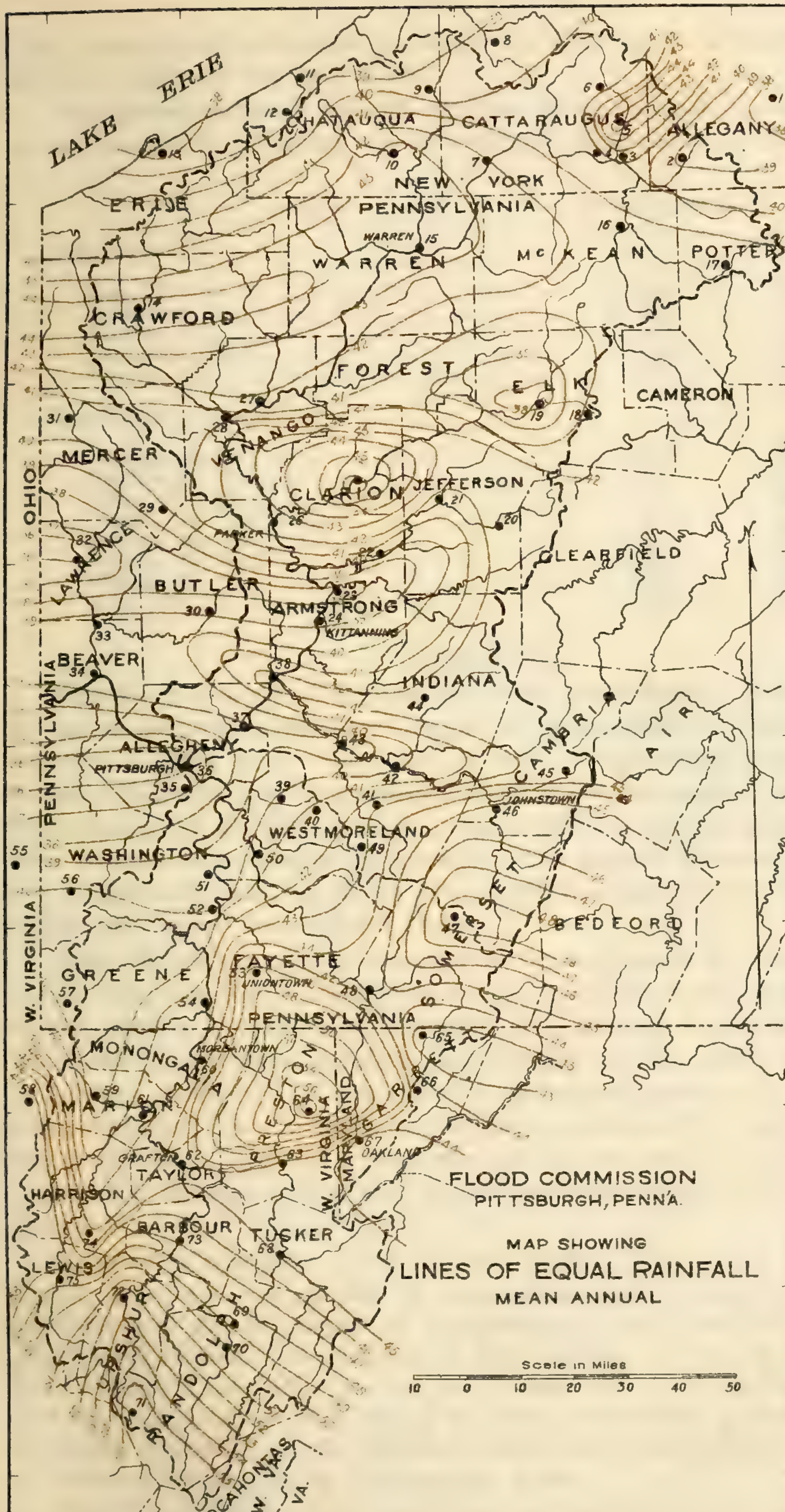
The distribution of rainfall throughout the year has an important bearing upon run-off and stream-flow. In the Allegheny and Monongahela Basins there is no marked wet or dry season. On the Allegheny Basin, figuring on a basis of 42.4 inches annual rainfall, the average spring rainfall is 10.3 inches, summer, 12.6 inches, autumn, 10.0 inches, and winter, 9.5 inches. The seasonal distribution on the Monongahela is very similar. This uniform seasonal distribution of the rainfall aids the streams in maintaining their flow during the evaporating season. During the winter months, the precipitation is largely in the form of snow and sleet, and the ground surface is frozen much of the time; so that if the snow melts before the ground thaws, much of the precipitation flows directly off in freshets. In the spring, however, the ground thaws, becoming moist and porous, and the water enters freely, to be stored up in underground channels and reservoirs. During the summer and fall, although the precipitation is as great as during the other seasons, much of the rain is absorbed by the dry ground or by vegetation, or evaporated by the hot sun, and the streams then reach their lowest stages.

Examining the rainfall by months, it is evident that July is the month of maximum rainfall, the mean monthly rainfall for this month being greater than for any other at 50 out of 79 stations. Again, taking actual rainfall for each month at each of the 84 stations, July was greater than all other months 322 times, June, 226 times, and May, 117 times.

The records show that in 16 cases on the Allegheny Basin and in 44 cases on the Monongahela Basin, the monthly rainfall recorded at various stations has exceeded 10 inches, while it has several times exceeded 15 inches.

MAXIMUM DAILY RAINFALL.

The intensity of the rainfall determines, to a large degree, the character of the run-off. A large monthly and annual rainfall over a drainage basin would not necessarily cause high floods unless it were at times concentrated into torrential rains. There are no records of rainfall for periods shorter than 24 hours, and as the rain gages are read daily at 8 A.M., the maximum figures rarely represent the greatest rainfall in 24 hours elapsed time, but only the greatest rainfall recorded for the 24 hours preceding 8 A.M. The difficulties in figuring flood run-off from rainfall, arising from the fact that no time of starting and stopping of rainstorms is recorded with the present system, have already been pointed out in Chapter VII. It is hoped that some type of automatic



TOTAL RAINFALL			INCHES
1	Alfred	N.Y.	36.91
2	Bolivar	" "	38.82
3	Olean	" "	41.50
4	Allegany	" "	40.10
5	Humphrey	" "	44.46
6	Franklinville	" "	41.12
7	Redhouse	" "	
8	Otto	" "	
9	Cherry Creek	" "	
10	Jamestown	" "	43.55
11	Westfield	" "	38.12
12	Volusia	" "	38.76
13	Erie	Pa.	37.97
14	Saegerstown	"	44.53
15	Warren	"	43.55
16	Smethport	"	41.56
17	Coudertsport	"	
18	St. Marys	"	41.43
19	Ridgway	"	38.63
20	Dubois	"	42.54
21	Brookville	"	41.53
22	Hawthorn	"	
23	Mahoning	"	37.80
24	Kittanning	"	
25	Clarion	"	46.46
26	Parkers L'ndg.	"	42.86
27	Oil City	"	41.99
28	Franklin	"	40.94
29	Grove City	"	39.86
30	Butler	"	
31	Greenville	"	40.68
32	Skidmore	"	35.28
33	Elwood J'ct.	"	39.53
34	Beaver Dam	"	39.67
35	Baldwin	"	
36	Pittsburgh	"	36.10
37	Springdale	"	39.25
38	Freeport	"	42.20
39	Irwin	"	40.53
40	Greensburg	"	36.08
41	Derry	"	43.05
42	Blairsville	"	
43	Saltsburg	"	38.66
44	Indiana	"	42.78
45	Cassandra	"	42.46
46	Johnstown	"	45.10
47	Somerset	"	48.50
48	Confluence	"	44.69
49	Lycippus	"	42.63
50	West Newton	"	40.83
51	Lock No. 4	"	39.24
52	California	"	39.74
53	Uniontown	"	46.76
54	Greensboro	"	42.50
55	Wellsburg	W.Va.	
56	Claysville	Pa.	40.06
57	Aleppo	"	40.44
58	Smithfield	W.Va.	47.31
59	Mannington	"	40.47
60	Morgantown	"	43.04
61	Fairmont	"	42.54
62	Grafton	"	44.40
63	Rowlesburg	"	44.84
64	Terra Alta	"	57.90
65	Grantsville	Md.	42.88
66	Deer Park	"	44.44
67	Oakland	"	43.79
68	Parsons	W.Va.	44.93
69	Elkins	"	48.61
70	Beverly	"	
71	Pickens	"	55.45
72	Buckhannon	"	52.30
73	Phillipi	"	46.42
74	Lost Creek	"	43.90
75	Weston	"	48.19

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gage, giving a graphical record of rainfall and showing its distribution throughout the 24 hours, may come into general use.

The greatest depths of rainfall recorded for the 24 hours preceding 8 A.M. at certain stations on the Allegheny and Monongahela Basins are as follows:

STATION	DEPTH IN INCHES	DATE
ALLEGHENY BASIN—		
Erie, Pa.	4.71	May, 1903.
Johnstown, Pa.	4.49	*
Parker, Pa.	3.75	*
Pittsburgh, Pa.	4.08	September, 1876.
Warren, Pa.	3.56	*
MONONGAHELA BASIN—		
Buckhannon, W. Va.	3.15	August 29, 1911.
Confluence, Pa.	3.40	*
Elkins, W. Va.	4.27	July 17, 1907.
Grafton, W. Va.	3.71	August 29, 1911.
Parsons, W. Va.	4.75	June 19, 1910.
Philippi, W. Va.	3.73	August 29, 1911.
Pickens, W. Va.	3.58	July 17, 1907.
Terra Alta, W. Va.	3.80	August 29, 1911.

SNOWFALL.

Relation to Run-off. The character of the precipitation, whether rain or snow, also has an important influence on run-off and stream-flow. If the precipitation is in the form of snow, it of course does not run off immediately; but, according to the weather conditions, may be gradually melted, or may be rapidly turned to water by high temperatures, and, possibly, by warm rains in addition, and running off rapidly into the water courses, cause considerable freshets. The greatest floods on the Allegheny have been caused in this way, but the greatest recorded run-off on the Monongahela occurred in July and resulted from rainfall alone.

Data. Reliable records of snowfall on the two basins are very limited, and until recently there has been practically no record preserved of the amount of snow on the ground, which is of course more important in estimating flood run-off. The Flood Commission has collected authentic snowfall data for the winter of 1909-1910, from the bulletins of the U. S. Weather Bureau, by correspondence with various sources of information, and from the notes of the survey parties of the Commission, which were then in the field. A complete discussion of the snowfall of this winter is given in Chapter III, together with a map of the two basins, Plate 1, showing lines of equal snowfall.

Snowfall of 1909-1910. A comparison of this map and the map in the present chapter, Plate 91, showing lines of mean annual rainfall, shows a very marked resemblance between the distribution of the snowfall of the winter of 1909-1910, and the mean annual rainfall. The summits of high rainfall, Clarion, Pa., Humphrey, N. Y., Somerset, Pa., Terra Alta, W. Va., and Pickens, W. Va., are also summits of high snowfall. The total snowfall during the winter varied from 47 inches at Pittsburgh to 112 inches at Clarion, on the Allegheny Basin; and from 29 inches at Morgantown to 117 inches at Pickens, on the Monongahela Basin.

Distribution. Although in general the total snowfall on the Allegheny and Monon-

*From Weather Bureau Reports, giving no date.

gahela Basins is nearly the same, there is a great difference in the length of time snow stays on the ground on the two basins. Over the whole Allegheny Basin, as far south as the mouth of the Kiskiminetas River, in the winter of 1909-1910, a blanket of snow from 2 to 5 feet in depth was the general condition. On the northern part of the basin, in a belt from a point a little north of Corry, Pa., southeast to Brookville, Pa., the snow lay to a depth of about 4 feet for over a month. South from the mouth of the Kiskiminetas to below Pittsburgh, the depth across the basin was considerably less. In fact, even on the high lands, a depth of 8 to 12 inches is about as great as is generally found for any considerable length of time on the Monongahela Basin south of the Pennsylvania state line. In this part of the basin, on the lower levels, and under about 1,500 feet, the ground is frequently bare for much of the winter.

RAINFALL TABLES.

The following tables show the monthly and annual rainfall for 84 stations on the Allegheny and Monongahela Basins for each year readings have been taken, together with the average monthly and annual rainfall at each station. Table No. 47, page 78, gives, for each station, the number of years of the record, and the maximum, minimum and mean annual rainfall.

RECORDS OF MONTHLY AND ANNUAL RAINFALL.

Aleppo, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	1.71	0.60	1.52	4.40	5.90	4.16	3.46	3.40	3.98	0.54	2.77	4.79	37.23
1902	2.57	2.24	4.46	4.16	1.90	3.67	8.55	2.99	3.95	2.95	3.02	5.54	46.00
1903	2.89	5.23	4.81	3.96	4.65	5.78	5.99	2.54	0.91	3.25	2.03	2.18	44.22
1904	2.27	2.12	5.99	3.98	2.71	4.82	3.38	3.23	1.63	1.39	0.26	2.91	34.69
1905	3.48	1.74	4.40	2.91	3.40	3.60	3.20	2.34	2.70	4.71	3.15	3.93	39.56
1906	3.20	1.24	3.89	3.43	2.00	4.14	3.48	6.28	2.56	2.23	1.39	5.09	38.93
1907	7.03	1.99	8.17	3.34	3.60	3.90	9.46	3.63	3.97	3.64	2.73	3.25	54.71
1908	2.09	3.55	6.05	4.70	5.86	1.73	3.75	2.62	0.81	1.44	0.65	2.62	35.87
1909	3.29	5.06	2.81	4.10	3.96	4.58	4.50	2.87	1.30	2.19	1.07	1.92	37.65
1910	6.85	3.87	0.25	3.10	4.18	2.54	5.15	1.12	2.52	1.80	1.80	2.40	35.55
Mean	3.54	2.76	4.23	3.81	3.82	3.89	5.09	3.10	2.43	2.41	1.88	3.46	40.44

Alfred, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1852	1.96	1.69	2.26	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1857	-----	-----	1.45	3.10	4.20	7.00	4.30	4.00	4.30	5.90	7.40	2.50	-----
1858	1.00	-----	0.28	2.42	6.95	6.60	2.40	1.99	2.70	6.27	1.40	1.60	-----
1859	1.70	2.20	1.00	2.90	3.90	7.10	-----	-----	3.20	1.50	0.90	2.90	-----
1860	1.40	1.40	2.00	-----	-----	2.55	2.78	8.11	3.69	3.37	2.94	1.54	-----
1861	2.53	4.98	2.55	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1889	3.10	1.50	1.40	2.25	2.80	5.66	4.47	1.85	1.82	2.44	3.48	2.55	33.32
1890	3.50	2.31	3.01	3.56	6.95	3.42	1.63	6.17	9.47	4.79	1.60	2.72	49.13
1891	2.22	3.30	2.54	2.21	0.60	2.46	5.30	5.01	1.22	2.61	1.73	3.60	32.80
1892	4.06	2.76	3.18	0.55	5.80	5.48	2.14	3.72	2.04	1.44	4.31	0.62	36.10
1893	4.45	4.15	3.34	2.23	5.89	1.93	3.02	4.95	4.90	3.30	2.98	3.13	44.27
1894	3.02	2.81	1.35	8.09	7.91	2.14	2.96	0.56	6.88	3.64	1.37	3.02	43.75
1895	3.39	0.95	1.30	1.61	2.90	4.69	2.60	4.27	0.95	1.13	3.34	4.03	31.16
1896	2.51	3.28	4.33	1.69	2.62	4.07	4.49	1.11	5.04	5.02	2.15	1.64	37.95
1897	3.33	1.67	3.24	2.69	3.35	2.97	5.47	1.78	2.88	1.02	3.25	3.85	35.50
1898	2.32	1.46	3.82	2.50	3.27	3.80	2.55	6.21	1.13	5.12	2.99	2.80	37.97
1899	2.20	1.68	2.07	0.71	3.07	1.80	1.70	1.21	3.12	1.34	2.40	4.05	25.35
1900	2.49	1.84	3.79	1.33	3.15	3.13	4.02	4.04	1.51	4.58	4.55	1.21	35.64
1901	1.22	0.81	1.24	7.17	5.88	-----	-----	-----	-----	1.14	2.38	4.32	-----
1910	-----	-----	-----	-----	3.38	1.43	4.16	2.55	3.44	2.64	3.60	3.28	-----
Mean	2.58	2.27	2.32	2.81	4.27	3.90	3.37	3.60	3.43	3.18	2.93	2.74	36.91

No records 1853-1856, 1862-1888 and 1902-1909.

Allegany, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1907	a3.65	1.52	3.65	3.44	4.20	4.76	2.70	1.11	2.68	3.81	2.38	3.27	38.17
1908	2.97	4.15	3.79	4.18	6.39	4.36	6.86	3.65	1.14	1.05	1.49	2.86	42.89
1909	2.38	4.41	1.46	3.47	2.38	4.11	3.62	2.48	3.73	3.91	1.47	2.09	35.51
1910	5.31	5.01	0.73	4.75	3.73	2.10	3.84	3.33	6.12	3.73	2.42	2.78	43.85
Mean	3.55	3.77	2.41	3.96	4.17	3.83	4.26	2.64	3.42	3.12	1.94	2.71	40.10

a. Estimated from Bolivar.

Angelica, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1856	2.85	0.55	-----	-----	-----	3.52	-----	1.83	4.82	1.77	-----	1.90	-----
1857	2.85	1.77	-----	4.40	-----	12.50	-----	-----	-----	-----	-----	-----	-----
1871	-----	0.60	-----	-----	1.01	2.57	3.02	3.72	0.68	2.15	1.64	2.86	-----
1872	2.34	0.70	1.38	0.90	1.00	3.00	4.73	2.99	1.70	5.83	2.24	1.80	28.61
1873	2.72	0.63	3.53	2.89	2.30	2.72	2.61	5.82	0.90	6.44	-----	-----	-----
1874	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.35	2.30	-----	-----
1875	-----	0.10	2.80	1.20	3.66	4.15	-----	-----	-----	-----	-----	-----	-----
1889	3.10	1.26	1.67	3.81	5.12	7.43	5.00	2.60	2.34	3.33	4.27	3.29	43.22
1890	3.47	2.33	2.63	3.59	7.38	4.52	2.94	6.72	8.72	4.72	2.28	2.77	52.07
1891	1.86	1.63	2.50	2.46	1.25	3.48	5.80	5.39	1.37	2.61	2.33	3.84	34.52
1892	3.27	3.06	3.55	1.57	7.31	5.14	2.55	3.67	2.68	2.51	3.60	1.13	40.04
1893	2.44	4.37	2.87	4.37	5.65	2.35	1.79	5.22	2.67	2.49	2.12	3.53	39.87
1894	4.45	2.81	1.78	7.77	8.82	2.02	4.14	2.26	7.14	3.27	1.70	2.23	48.49
1895	3.35	1.38	2.86	2.72	2.01	4.10	2.40	3.96	1.92	1.32	3.46	4.02	33.50
1896	2.34	4.16	4.21	1.58	1.99	3.26	5.66	2.63	4.96	3.18	2.08	1.23	37.28
1897	3.12	1.57	4.21	3.15	4.07	5.56	5.14	1.77	1.74	0.65	3.07	3.10	37.15
1898	3.16	1.41	3.39	2.72	3.51	5.28	1.79	8.87	1.93	4.76	3.00	2.58	42.40
1899	2.04	1.64	2.72	0.90	2.39	1.81	2.56	2.05	2.86	2.99	2.09	3.97	28.02
1900	2.61	2.33	3.76	1.44	2.62	2.56	4.04	2.59	1.47	4.52	5.40	2.15	35.49
1901	2.62	2.04	2.95	5.29	5.23	3.69	3.34	4.87	3.11	1.15	2.88	4.77	41.94
1902	2.80	1.80	2.53	3.76	3.97	5.79	12.46	3.35	4.46	2.06	0.79	1.95	45.72
1903	1.78	1.45	4.60	2.65	1.16	4.54	4.11	7.51	1.80	3.10	2.57	0.77	36.04
1904	2.69	1.48	2.47	1.97	4.00	-----	6.54	-----	-----	-----	-----	-----	-----
1905	-----	-----	-----	-----	-----	-----	-----	2.77	2.58	3.04	1.86	2.79	-----
1906	1.59	0.58	3.08	1.42	3.70	4.28	4.69	8.33	3.63	4.66	1.90	2.49	40.35
1907	2.27	1.00	2.15	3.47	2.49	3.33	2.66	1.20	4.17	3.46	1.38	3.45	31.03
1908	1.99	3.95	2.46	3.18	6.38	3.78	3.93	3.46	0.77	0.69	1.20	1.79	33.58
1909	2.54	3.42	1.93	4.16	2.82	3.35	1.37	2.20	1.92	2.52	1.36	1.19	28.78
1910	4.14	3.75	0.54	5.92	3.12	0.42	3.28	3.36	2.09	2.62	2.35	2.09	33.68
Mean	2.73	1.92	2.66	2.97	3.72	4.27	4.02	3.97	2.89	2.97	2.41	2.57	37.70

No records 1858-1870 and 1876-1888.

Arcade, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	-----	-----	-----	-----	4.91	8.41	4.65	2.18	-----	-----	-----	-----	-----
1890	-----	-----	-----	-----	8.33	5.23	3.52	3.86	7.94	5.98	3.59	1.64	-----
1891	1.82	4.04	1.87	1.32	1.87	4.69	5.11	5.00	2.36	2.16	3.10	4.09	37.43
1892	2.52	3.35	1.77	1.34	7.16	9.33	4.59	4.78	2.59	3.63	3.33	1.51	45.90
1893	1.69	4.60	2.64	4.47	7.28	3.63	2.88	6.55	3.19	3.77	1.95	3.82	46.47
1894	3.12	2.50	1.83	6.02	10.05	5.35	2.70	1.57	5.54	4.22	1.83	1.65	46.38
1895	3.79	0.99	1.09	1.51	1.90	4.04	2.38	5.71	1.61	2.26	2.77	3.92	31.97
1896	2.35	3.86	3.50	1.36	2.48	3.19	6.39	3.77	6.18	3.22	3.68	1.66	41.64
1897	2.70	1.76	2.80	3.06	4.30	2.64	8.35	3.62	1.13	0.97	4.35	3.47	39.15
1898	4.29	1.66	2.97	2.90	4.62	6.17	2.98	6.20	4.77	5.31	3.79	3.15	48.81
1899	2.22	1.49	2.41	1.04	4.92	1.78	2.90	0.45	5.10	3.07	1.70	4.46	31.54
1900	4.00	3.31	2.77	1.82	2.40	2.12	5.45	3.95	-----	-----	-----	-----	-----
1901	-----	-----	-----	-----	4.53	3.68	2.96	-----	-----	-----	-----	-----	-----
1902	-----	-----	-----	-----	2.86	6.15	10.51	2.95	4.52	4.39	1.97	2.63	-----
1903	3.51	2.42	4.22	4.13	1.63	4.14	-----	-----	-----	3.53	2.47	2.70	-----
1904	4.31	4.17	5.05	3.02	3.77	4.06	5.30	3.09	3.25	3.12	0.58	3.89	43.61
1905	5.60	2.00	1.28	2.26	2.71	4.44	4.72	2.33	1.89	3.18	3.18	3.15	36.74
1906	4.00	0.67	5.00	2.55	-----	2.91	-----	5.01	2.35	-----	-----	2.87	-----
1907	4.52	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	3.23	2.63	2.80	2.63	4.45	4.82	4.71	3.81	3.84	3.49	2.74	2.98	40.88

Baldwin, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1906	-----	0.60	3.22	0.75	4.40	5.62	3.45	6.51	2.75	5.51	1.74	2.84	-----
1907	2.85	1.94	3.89	3.75	3.69	4.83	4.83	0.88	4.32	2.41	2.44	3.35	39.18
1908	1.83	5.35	5.67	5.55	4.14	3.14	6.04	2.19	-----	0.83	1.25	3.35	-----
1909	3.59	5.42	3.46	-----	2.39	6.13	2.79	1.87	1.58	2.55	1.49	3.27	-----
1910	7.56	4.03	0.35	3.63	3.48	1.68	3.09	2.93	8.45	2.30	2.09	6.97	46.56
Mean	3.98	3.47	3.32	4.67	3.62	4.28	4.04	2.88	4.27	2.72	1.80	3.96	-----

Beaver Dam, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	-----	-----	2.99	2.79	1.73	5.74	3.61	2.39	1.98	5.50	1.54	4.29	-----
1903	2.95	3.45	4.34	2.52	0.63	5.74	4.29	7.61	1.35	2.07	4.46	1.77	41.18
1904	2.12	3.03	7.02	4.33	3.50	6.46	5.49	4.09	1.13	1.54	0.53	3.01	42.25
1905	2.47	2.50	4.34	3.22	5.01	7.17	2.53	3.43	4.51	3.07	2.78	3.31	45.00
1906	2.44	0.96	3.44	2.23	2.93	3.99	7.28	3.52	3.90	2.95	2.16	3.32	39.12
1907	6.83	1.25	6.99	3.12	3.37	4.85	5.72	2.66	5.40	-----	2.80	2.66	-----
1908	2.08	3.45	5.90	3.69	4.75	2.01	4.70	5.01	0.67	1.56	0.84	2.71	37.37
1909	3.02	5.46	3.44	6.03	2.76	7.73	3.57	1.11	0.86	1.70	1.25	2.53	39.46
1910	5.15	3.72	0.27	2.27	2.56	2.55	2.89	3.24	5.36	1.11	1.32	2.59	33.03
Mean	3.38	2.98	4.30	3.36	3.03	5.14	4.45	3.67	2.80	2.45	1.96	2.91	39.67

Bolivar, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	-----	-----	-----	1.48	4.70	4.29	7.75	1.25	4.86	4.03	1.42	1.38	-----
1897	2.31	1.44	3.37	2.48	2.80	3.44	6.36	3.26	2.06	0.70	4.59	3.02	35.83
1898	3.91	1.76	5.36	2.90	3.46	5.12	-----	6.28	1.27	4.97	3.40	2.04	-----
1899	2.19	2.03	2.81	1.09	3.60	2.19	4.30	1.72	3.14	2.27	1.91	4.58	31.83
1900	3.42	2.54	3.51	1.22	2.68	2.98	4.01	5.14	2.18	5.94	6.29	1.81	41.72
1901	2.20	1.56	2.90	4.53	4.93	2.94	4.75	3.67	3.77	1.37	3.41	5.27	41.30
1902	2.27	1.99	2.11	3.62	3.14	6.66	10.87	2.68	2.98	2.68	1.56	3.08	43.64
1903	2.85	3.14	4.75	2.47	2.43	5.60	4.62	5.46	2.48	4.11	2.89	1.52	42.32
1904	3.81	3.04	4.23	2.37	4.58	1.59	6.30	2.30	4.43	2.74	0.83	2.41	38.63
1905	3.07	0.85	3.34	2.65	1.61	6.49	6.77	2.62	2.53	4.52	2.98	3.12	40.35
1906	2.02	0.61	3.31	1.91	3.98	2.39	2.00	6.18	5.23	4.68	1.50	3.07	36.88
1907	3.83	0.58	2.64	3.46	3.50	4.60	2.36	-----	-----	-----	-----	-----	-----
1908	-----	-----	-----	3.33	-----	-----	4.75	-----	-----	1.06	1.29	2.18	-----
1909	2.78	4.42	2.54	5.31	3.85	4.63	1.38	2.06	3.22	3.06	1.66	1.48	36.39
1910	4.75	4.05	0.46	5.47	3.65	1.72	3.11	3.50	4.22	1.64	3.28	2.30	38.15
Mean	3.03	2.15	3.19	2.92	3.49	3.90	4.95	3.55	3.26	3.13	2.64	2.49	38.82

Brookville, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	4.53	1.60	1.52	3.16	7.34	3.63	5.47	13.28	2.91	5.68	3.72	2.64	55.48
1886	3.79	1.39	1.91	2.31	1.79	1.63	1.79	1.16	3.13	1.11	4.42	1.80	26.23
1887	2.12	5.50	1.93	2.45	2.13	2.31	2.18	3.20	3.39	1.06	3.41	2.64	32.32
1888	4.47	1.06	2.03	2.44	2.12	1.60	-----	-----	-----	1.24	2.52	2.23	-----
1889	2.93	2.34	2.30	5.28	6.09	9.36	4.13	2.82	3.40	2.36	3.72	2.37	47.10
1890	2.56	2.30	2.19	2.90	7.32	2.26	2.08	4.70	5.47	6.63	2.58	3.30	44.29
1891	2.86	4.94	4.13	2.47	1.59	4.52	6.05	3.43	1.33	1.39	4.55	3.98	41.24
1892	3.48	3.00	3.72	1.74	7.17	6.30	3.63	1.74	2.48	0.48	2.86	1.65	38.25
1893	2.38	7.03	2.44	4.83	5.02	4.23	4.73	2.81	2.06	2.49	2.19	3.39	43.59
1894	2.77	2.59	1.34	3.00	6.35	2.03	2.18	0.40	8.12	2.38	1.39	4.48	37.03
1895	3.17	0.99	2.33	3.33	1.71	3.79	3.06	2.43	3.37	0.76	3.96	3.56	32.46

Brookville, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	0.80	2.82	2.47	2.28	1.51	4.42	10.90	3.58	5.55	3.19	3.13	1.84	42.50
1897	2.04	1.49	4.95	1.85	1.71	5.19	9.97	3.29	2.85	0.53	5.36	4.82	44.15
1898	5.22	1.69	7.42	2.35	4.16	2.95	2.02	5.92	1.46	4.47	3.09	2.04	42.79
1899	2.70	1.71	3.73	1.96	5.39	4.89	5.52	1.68	4.92	2.48	1.67	3.87	40.52
1900	1.84	4.54	3.06	1.47	2.33	3.25	6.08	3.45	2.49	3.33	4.94	1.56	38.34
1901	1.68	0.74	1.78	5.82	5.05	3.98	2.73	8.61	2.47	1.08	3.94	3.32	41.20
1902	3.04	2.65	3.64	3.40	3.68	6.80	7.02	0.94	2.34	2.93	1.70	4.96	43.10
1903	3.46	4.24	5.62	4.20	1.44	5.10	6.32	5.70	2.44	3.50	4.06	2.20	48.28
1904	3.90	1.70	6.89	6.14	3.90	3.34	5.89	3.18	1.06	2.09	0.76	3.10	41.95
1905	3.24	1.50	4.36	2.60	2.52	6.14	7.40	3.97	4.12	5.48	3.72	4.76	49.87
1906	3.08	0.76	3.20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	3.00	2.57	3.32	3.14	3.82	4.18	4.96	3.81	3.27	2.60	3.22	3.07	41.53

Discontinued March 31, 1906.

Buckhannon, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	3.10	3.46	2.19	5.30	6.01	5.76	8.31	2.33	3.52	4.54	7.24	2.78	54.54
1890	5.26	6.16	7.62	5.10	6.03	8.28	3.06	3.79	5.63	8.59	2.54	5.49	67.55
1891	4.29	5.87	5.46	3.37	4.10	5.92	7.95	7.10	2.25	2.62	3.80	5.46	57.29
1892	3.68	2.05	3.35	5.76	6.11	5.00	2.60	4.11	3.42	1.15	4.39	3.13	44.75
1893	2.48	4.61	1.61	6.99	4.34	2.72	5.30	2.87	2.08	3.85	2.51	2.52	41.88
1894	3.28	3.60	2.63	4.73	4.04	3.30	1.94	2.07	1.30	3.20	3.38	4.60	38.07
1895	4.14	0.91	4.15	5.47	2.19	2.55	3.67	2.77	2.05	1.94	2.67	2.68	35.19
1896	2.55	3.21	5.09	3.48	2.44	4.77	13.63	1.91	4.87	3.31	5.01	2.58	52.85
1897	1.79	6.10	4.36	3.37	5.05	6.42	4.94	2.49	2.79	0.25	6.19	6.76	50.51
1898	6.74	2.68	8.00	4.45	5.13	3.97	4.16	8.96	3.79	6.02	3.79	3.45	61.14
1899	6.38	5.02	5.96	1.97	3.99	6.33	4.87	2.78	3.39	-----	-----	-----	-----
1900	2.04	4.99	3.75	1.58	3.31	4.30	4.09	2.57	1.29	3.87	6.69	3.09	41.57
1901	2.71	1.34	3.78	6.86	7.03	4.90	-----	-----	3.55	0.66	2.89	7.74	-----
1902	4.63	3.39	4.29	2.57	3.50	6.06	3.97	3.55	-----	-----	-----	6.23	-----
1903	3.41	6.43	3.93	4.15	6.24	-----	-----	-----	-----	2.12	-----	4.43	-----
1904	2.84	3.92	4.61	3.23	2.97	-----	5.98	-----	-----	-----	0.33	3.87	-----
1905	3.55	2.60	5.42	3.54	5.09	3.63	7.37	3.20	2.19	4.17	2.48	3.45	46.69
1906	4.25	3.31	8.11	5.00	2.76	-----	-----	-----	-----	-----	-----	-----	-----
1907	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1908	-----	-----	-----	4.33	5.91	5.46	6.16	2.51	1.10	0.86	0.95	3.14	-----
1909	2.91	4.71	4.02	6.08	2.96	6.53	4.51	4.90	3.56	5.27	2.22	2.46	50.13
1910	6.85	3.25	0.45	2.10	4.49	6.20	5.31	1.97	2.54	2.31	1.89	2.67	40.03
Mean	3.84	3.88	4.44	4.26	4.46	5.12	5.43	3.52	2.90	3.22	3.47	4.03	52.30

California, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	2.03	1.52	3.58	5.00	2.12	3.85	7.33	1.85	2.23	5.21	1.84	4.33	39.89
1903	2.40	4.95	3.98	3.23	1.78	6.70	3.56	2.36	2.72	2.73	2.08	1.43	37.92
1904	2.78	1.90	4.82	3.99	3.68	3.09	2.63	5.32	1.31	1.46	0.44	2.09	33.51
1905	2.50	1.73	4.07	3.68	2.68	7.75	5.29	3.09	2.57	4.84	2.27	3.70	44.17
1906	1.77	1.07	4.05	1.87	3.53	4.00	4.91	8.10	1.58	3.30	0.84	4.42	39.44
1907	5.03	1.68	7.14	2.13	3.07	4.36	4.56	3.90	4.18	1.96	1.68	3.81	43.50
1908	1.30	3.84	6.67	-----	-----	-----	-----	-----	-----	0.18	0.55	1.95	-----
1909	-----	-----	-----	-----	1.98	-----	-----	-----	1.35	3.00	-----	-----	-----
1910	-----	-----	-----	-----	1.15	4.20	-----	-----	-----	1.05	1.91	-----	-----
Mean	2.54	2.39	4.90	3.32	2.50	4.75	4.71	4.10	2.28	2.64	1.45	3.10	39.74

Cassandra, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1894	-----	-----	-----	3.78	14.57	1.67	1.69	2.37	5.25	2.81	3.18	4.04	-----
1895	4.71	1.45	3.22	3.61	4.66	3.65	4.85	2.27	3.69	1.11	2.21	3.68	39.11
1896	2.10	4.38	5.24	2.89	2.33	6.33	6.75	3.58	6.77	2.89	3.10	1.46	47.82
1897	3.18	3.43	3.70	3.56	4.18	2.88	3.44	2.40	2.86	0.39	4.88	3.75	38.65
1898	3.79	1.85	5.22	1.83	6.35	3.11	3.73	6.49	1.61	7.12	2.51	2.61	46.22
1899	2.87	3.11	4.61	1.93	4.78	3.88	4.36	3.77	3.70	0.79	3.19	3.63	40.62
1900	2.96	4.00	2.98	2.77	1.43	7.09	6.73	4.41	1.16	2.99	4.20	1.16	41.88
1901	2.54	2.75	3.49	5.34	5.83	4.21	3.71	5.42	3.13	0.70	3.73	3.73	44.58
1902	3.14	4.75	3.75	5.44	1.61	5.72	8.42	2.14	2.02	5.73	1.36	4.16	48.24
1903	2.89	4.42	3.47	2.45	3.28	5.59	4.56	4.15	1.85	3.00	3.99	2.71	42.36
1904	3.89	3.41	3.58	1.58	3.11	4.74	6.05	3.20	2.30	1.87	1.20	3.13	38.06
1905	2.97	1.30	3.97	2.74	2.80	7.58	3.80	2.04	2.15	3.42	2.73	3.61	39.11
1906	2.35	1.70	4.40	1.62	3.04	4.74	3.09	9.23	1.35	2.22	1.29	3.26	38.29
1907	3.92	1.69	7.05	2.02	2.43	6.90	4.34	5.82	3.33	3.19	2.60	3.85	47.14
Mean	3.18	2.94	4.21	2.97	4.32	4.86	4.68	4.09	2.94	2.73	2.87	3.20	42.46

No record since 1907.

Central Station, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1891	2.60	-----	-----	-----	-----	-----	-----	-----	-----	1.68	1.57	-----	-----
1892	-----	-----	-----	-----	-----	4.37	7.20	1.94	2.91	1.11	4.07	2.59	-----
1893	3.92	6.70	1.48	5.70	3.37	4.18	3.86	4.90	2.48	4.66	2.62	2.17	46.04
1894	4.09	3.57	2.50	2.68	4.02	4.15	0.65	2.64	2.42	1.90	2.97	4.14	35.73
1895	-----	-----	2.39	2.10	0.79	2.62	3.68	1.44	-----	-----	-----	-----	-----
1899	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.68	1.57	3.11	-----
1900	2.60	3.77	3.37	1.08	3.41	4.60	5.30	2.09	0.55	1.78	4.87	1.76	35.18
1901	2.00	0.61	3.38	8.86	5.26	4.29	3.87	3.91	4.23	0.78	2.81	4.67	44.67
1902	3.45	2.08	3.00	3.47	2.98	6.99	4.13	2.36	3.68	1.44	3.29	5.64	42.51
1903	2.09	6.48	4.00	4.84	5.23	4.22	3.70	2.50	2.05	3.00	3.51	2.17	43.79
1904	2.27	1.92	3.37	2.56	1.99	6.07	2.78	1.69	1.65	1.19	0.36	3.37	29.22
1905	3.19	2.20	3.89	2.63	4.27	2.86	3.56	4.30	2.79	7.02	3.57	3.51	43.79
1906	3.60	1.40	3.98	3.18	2.00	4.58	3.32	4.72	2.76	1.86	2.34	4.51	38.25
1907	7.94	1.77	3.09	2.73	3.28	4.54	7.22	4.32	6.88	2.50	3.24	3.51	51.02
1908	2.11	3.16	5.30	3.33	5.72	1.93	5.79	1.82	0.59	1.49	0.80	2.80	34.84
1909	3.17	5.14	2.43	a5.45	5.71	6.47	3.07	4.84	2.77	2.03	0.89	2.17	44.14
1910	6.50	3.51	0.19	2.67	4.75	1.86	3.84	2.95	4.04	1.62	a2.14	2.24	36.31
Mean	3.54	3.25	3.03	3.66	3.77	4.25	4.13	3.09	2.84	2.23	2.54	3.22	40.42

Record incomplete 1896-1898.
a. Estimated from surrounding stations.

Clarion, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1888	4.88	1.79	-----	2.82	3.46	-----	-----	-----	2.82	5.15	-----	2.75	-----
1889	3.35	2.10	1.91	2.09	4.59	-----	-----	-----	3.32	2.17	3.73	3.61	-----
1890	6.87	4.78	3.98	-----	7.20	-----	-----	-----	-----	5.19	1.77	-----	-----
1891	2.93	7.02	4.04	2.84	1.35	6.93	8.98	4.16	2.51	2.47	4.31	4.66	52.20
1892	3.20	3.70	3.83	2.25	8.75	7.21	2.90	2.18	3.59	1.46	3.58	1.62	44.27
1893	2.90	9.26	4.20	6.91	5.09	6.50	6.27	4.12	2.53	3.46	2.54	4.78	58.56
1894	4.19	2.97	2.10	4.41	8.02	2.88	2.34	0.44	12.36	2.95	2.61	3.94	49.21
1895	4.13	2.48	2.24	2.56	2.28	4.27	5.05	3.55	4.60	0.66	4.33	-----	-----
1901	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	4.00	-----
1902	1.88	1.98	3.70	3.49	3.54	6.14	10.17	2.26	2.32	3.48	1.82	5.99	46.77
1903	4.31	3.96	5.66	3.34	2.10	6.00	5.18	6.76	1.48	3.22	4.12	2.07	48.20
1904	3.98	3.78	6.46	5.72	3.92	3.72	6.06	4.61	1.00	1.70	0.68	2.99	44.62

Clarion, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	3.30	2.58	4.60	2.72	2.96	5.46	8.70	3.68	3.38	5.24	3.50	4.22	50.34
1906	2.68	0.68	3.04	2.86	3.36	1.40	2.86	8.22	3.78	3.70	1.94	3.89	38.41
1907	5.28	1.62	4.18	3.28	2.76	5.38	3.02	1.60	5.10	3.82	2.21	2.92	41.17
1908	2.80	4.60	6.24	3.90	5.62	1.84	5.28	1.46	1.30	0.46	1.16	2.64	37.36
1909	3.64	4.00	2.94	6.44	2.25	5.73	2.21	0.12	-----	-----	-----	-----	-----
1910	7.90	4.40	0.82	3.62	3.01	1.09	0.42	2.79	5.44	2.96	3.42	3.64	39.51
Mean	4.50	3.63	3.75	3.70	4.13	4.61	4.96	3.28	3.70	3.01	2.78	3.58	45.90

No records 1896–1900.

Claysville, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1904	-----	-----	-----	3.08	3.74	4.70	6.92	2.09	2.24	1.80	0.27	2.65	-----
1905	2.68	1.16	3.02	3.46	3.43	8.12	3.71	4.76	2.34	3.79	2.83	3.19	42.49
1906	1.93	1.01	3.50	2.74	1.97	5.21	3.63	4.53	3.14	3.36	1.12	3.04	35.18
1907	3.92	1.54	7.66	3.49	3.83	4.43	6.10	3.96	5.68	2.84	2.08	2.80	48.33
1908	1.80	4.25	7.35	4.64	4.30	2.66	6.97	4.16	0.53	1.65	0.72	2.77	41.80
1909	3.41	5.58	3.05	4.52	3.20	3.50	3.43	2.17	1.47	2.12	0.77	2.23	35.45
1910	6.94	4.51	0.13	2.65	4.71	3.11	2.88	2.17	3.74	1.92	1.57	2.77	37.10
Mean	3.45	3.01	4.12	3.51	3.60	4.53	4.95	3.41	2.72	2.64	1.24	2.78	40.06

Colebrook, Ohio.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1858	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.09	2.50	1.93	-----
1859	1.72	2.18	1.79	2.87	1.54	2.25	1.10	4.83	2.73	2.01	4.54	3.21	30.77
1860	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1861	1.55	1.57	2.21	4.01	3.14	1.98	3.34	2.56	2.16	2.12	2.88	1.10	28.62
1862	3.41	1.79	3.27	2.56	3.64	4.04	3.56	0.51	1.16	1.63	3.03	4.29	32.89
1863	5.28	3.05	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1892	-----	-----	-----	-----	-----	-----	-----	3.43	2.05	1.97	2.29	1.18	-----
1893	1.96	3.71	2.04	4.19	7.65	3.26	2.20	3.72	0.83	5.99	2.85	3.59	41.99
1894	2.55	2.36	1.31	2.03	2.92	3.44	1.63	0.33	5.40	2.66	2.68	2.14	29.45
1895	3.54	1.03	1.50	1.85	3.78	2.04	3.25	3.99	4.25	1.54	4.13	4.43	35.33
1896	1.07	2.58	3.02	2.88	2.44	4.78	7.07	3.97	6.08	1.52	2.38	1.59	39.38
1897	1.74	2.40	2.96	2.41	4.81	2.53	7.14	8.40	1.27	1.43	6.77	2.84	44.70
1898	2.98	2.16	3.89	1.74	-----	-----	-----	-----	-----	-----	3.69	1.69	-----
1899	2.60	1.34	3.31	0.64	3.97	2.30	3.53	0.45	3.48	2.30	0.80	4.67	29.39
1900	2.39	2.20	1.63	1.70	4.03	2.75	6.32	1.65	2.83	2.19	3.81	1.34	32.84
1901	1.68	0.60	2.65	3.05	2.85	2.39	3.99	5.22	3.99	0.28	2.47	3.40	32.57
1902	2.51	0.90	1.58	3.04	3.30	5.15	9.85	1.92	3.27	1.50	-----	3.50	-----
1903	-----	-----	2.96	4.19	1.72	-----	5.79	9.33	2.07	5.16	-----	-----	-----
1904	-----	-----	5.14	2.70	7.01	-----	7.61	3.36	-----	-----	-----	2.35	-----
1905	0.57	1.35	2.00	2.32	4.41	4.28	7.65	3.29	3.65	4.08	2.95	1.22	37.77
1906	1.19	1.12	2.88	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1907	-----	-----	3.40	1.91	2.86	-----	5.59	0.82	3.12	4.56	3.00	3.87	-----
1908	2.05	4.84	4.16	4.04	3.29	1.68	1.58	1.63	0.58	1.21	1.38	3.74	30.18
1909	2.93	4.55	2.35	4.24	4.29	7.95	4.11	1.51	3.37	-----	2.66	2.81	-----
Mean	2.32	2.21	2.70	2.76	3.76	3.39	4.74	3.21	2.79	2.40	3.04	2.74	34.30

Note: Records for 1858 to 1863 are for Montville, about 15 miles northwest of Colebrook, and for 1907, 1908 and 1909 for Rome, about 6 miles northwest of Colebrook. No records from March, 1863 to July, 1892.

Confluence, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1875	1.74	2.18	3.97	2.26	2.35	2.79	7.79	4.69	1.54	2.51	4.03	3.28	39.13
1876	3.62	4.24	3.15	3.42	4.21	3.94	6.15	1.99	10.09	1.83	2.12	1.64	46.40
1877	4.01	1.59	4.70	2.87	2.14	7.13	6.35	1.11	3.17	4.00	6.06	1.88	45.01
1878	4.47	0.63	3.24	3.74	3.15	2.43	4.35	2.52	2.66	3.96	6.08	3.84	41.07
1879	2.66	3.08	5.82	1.56	1.49	3.50	4.48	5.06	1.16	1.76	2.67	5.53	38.77
1880	6.06	4.45	4.27	3.41	2.39	6.69	5.45	4.88	3.60	2.18	1.97	3.83	49.18
1881	2.99	3.51	2.28	1.97	3.83	9.91	3.62	0.08	1.17	3.68	2.24	5.99	41.27
1882	7.90	6.07	6.80	2.07	5.97	5.51	3.26	5.20	1.88	1.93	2.33	3.18	52.10
1883	4.23	6.57	3.03	4.42	4.78	3.72	6.86	3.87	2.87	3.34	2.49	3.63	49.81
1884	4.07	6.50	5.19	2.84	2.79	1.78	6.29	1.92	1.56	2.68	1.63	4.90	42.15
1885	5.79	2.76	2.42	3.20	3.27	1.82	2.70	5.45	1.10	4.34	2.80	3.67	39.32
1886	3.42	2.49	3.27	2.78	4.96	5.53	3.54	4.51	4.11	1.07	5.50	2.89	44.07
1887	2.09	7.19	1.42	4.43	4.19	-----	3.49	2.99	4.21	1.17	1.33	1.52	-----
1888	7.62	2.02	3.30	2.70	5.38	3.40	-----	-----	-----	5.47	3.05	2.25	-----
1889	1.99	2.63	1.98	3.21	4.46	4.69	4.22	3.38	1.90	3.33	4.82	3.35	39.96
1890	4.63	5.23	6.94	4.75	6.12	3.38	2.88	5.75	5.84	8.06	2.55	4.06	60.19
1891	4.51	8.00	4.36	3.12	3.73	6.83	6.57	5.92	3.62	3.31	3.45	4.06	57.48
1892	3.09	2.92	3.26	4.74	5.07	4.93	4.18	2.54	1.57	0.90	3.18	2.06	38.44
1893	2.37	5.71	1.36	6.37	6.64	2.89	2.65	3.25	2.46	3.99	2.72	2.98	43.39
1894	3.15	3.57	2.36	4.94	5.86	2.90	3.00	1.37	3.48	2.71	2.87	5.93	42.14
1895	2.98	1.43	4.03	3.57	1.94	4.28	6.18	3.75	0.68	0.67	3.02	2.58	35.11
1896	1.09	3.32	4.21	2.89	4.03	4.77	12.11	2.47	6.77	2.52	3.88	1.98	50.04
1897	3.54	5.88	4.38	3.33	3.91	2.48	6.46	2.56	2.56	0.43	5.89	4.36	45.78
1898	6.79	2.40	6.79	2.83	4.35	3.14	4.59	8.26	2.20	5.22	3.41	3.19	53.17
1899	4.37	3.34	6.13	2.41	5.71	4.18	6.64	2.53	5.68	0.70	3.90	3.32	48.91
1900	2.44	4.02	3.97	1.66	2.06	5.88	8.26	2.38	1.45	3.08	6.68	2.15	44.03
1901	2.91	1.25	4.35	5.86	6.32	1.99	3.55	4.07	2.49	0.85	2.88	4.65	41.17
1902	2.80	2.70	4.44	5.08	4.37	4.08	5.56	2.17	2.39	4.45	1.65	6.23	45.92
1903	4.46	1.98	2.93	3.00	3.16	3.74	5.90	3.22	1.64	2.64	2.91	1.54	37.12
1904	2.87	2.66	4.18	3.20	4.03	1.62	2.34	4.08	1.20	1.53	0.43	3.24	31.38
1905	3.94	2.22	4.98	3.59	3.80	6.64	6.43	5.82	1.98	4.36	3.68	3.65	51.09
1906	4.30	1.15	4.81	4.19	3.56	4.36	3.79	8.14	3.34	2.28	1.67	7.08	48.67
1907	9.69	3.53	7.64	3.82	4.06	5.99	5.02	4.32	3.24	2.24	3.22	3.06	55.83
1908	3.16	3.87	6.44	3.92	6.54	3.14	7.24	3.00	0.80	0.08	0.82	3.10	42.11
1909	3.04	4.30	2.90	5.86	2.80	5.08	2.87	6.30	2.68	3.06	0.72	3.34	42.95
1910	6.82	2.36	0.38	3.38	3.16	5.56	2.70	1.88	4.54	1.48	1.82	2.22	36.30
Mean	4.04	3.55	4.04	3.54	4.07	4.31	5.07	3.75	2.90	2.72	3.07	3.44	44.69

Creston, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1900	-----	-----	-----	-----	-----	-----	-----	-----	0.99	1.73	4.81	1.98	-----
1901	2.15	0.94	3.12	9.87	4.92	7.61	1.05	3.80	3.06	0.08	2.60	4.39	43.59
1902	1.72	2.08	3.93	2.77	1.75	4.00	3.17	1.12	1.23	2.57	2.65	6.53	33.52
1903	2.55	4.74	3.79	5.28	1.96	4.50	3.12	1.08	1.08	2.93	2.90	2.00	35.93
1904	2.12	2.11	4.87	2.39	1.54	5.86	1.12	0.76	0.60	0.37	0.07	1.63	23.44
1905	1.83	1.79	3.51	2.06	4.91	3.74	4.35	4.50	3.27	5.72	2.99	1.30	39.97
1906	3.75	2.73	4.93	2.50	1.61	4.82	2.29	2.98	3.63	2.52	1.90	5.46	39.12
1907	7.29	2.19	4.56	3.38	3.86	5.13	4.78	4.49	2.74	2.44	2.05	1.96	44.87
1908	0.91	1.86	6.45	4.83	8.43	2.55	8.99	5.63	1.94	2.36	0.85	2.87	47.67
1909	2.67	4.84	2.44	5.15	4.13	4.68	4.91	2.81	2.66	2.67	1.26	2.06	40.28
1910	6.62	3.47	0.36	2.68	3.83	4.32	3.13	1.42	3.04	1.94	1.97	3.21	35.99
Mean	3.16	2.67	3.80	4.09	3.64	4.72	3.69	2.86	2.20	2.30	2.19	3.04	38.43

Davis Island Dam, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	1.00	0.45	3.49	2.60	2.78	5.16	6.80	1.59	2.55	2.61	1.18	3.68	33.89
1903	2.70	3.75	4.99	2.55	1.32	6.25	4.14	5.37	1.10	2.90	2.45	0.92	38.44
1904	3.53	2.27	5.38	3.29	3.31	5.93	4.44	2.78	3.14	1.48	0.19	2.61	38.35
1905	1.89	1.65	3.00	2.66	3.25	6.06	5.19	2.70	2.63	2.83	2.50	3.09	37.45
1906	2.07	1.28	3.90	1.93	2.44	6.43	6.72	1.72	3.60	2.73	1.13	2.88	36.83
1907	5.32	1.27	5.56	2.11	2.98	3.28	5.93	1.41	2.18	2.44	2.44	3.29	38.21
1908	2.25	3.55	5.60	3.53	5.27	1.29	3.18	2.72	0.84	1.37	0.74	2.65	32.99
1909	2.86	4.70	3.49	4.95	2.47	3.80	1.07	1.87	0.64	1.81	0.83	2.81	31.30
1910	5.96	3.67	0.30	2.46	3.55	2.18	1.78	1.56	5.03	1.61	1.48	2.67	32.25
Mean	3.06	2.51	3.97	2.89	3.04	4.49	4.36	2.41	2.41	2.20	1.44	2.73	35.52

Deer Park, Md.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1894	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.31	1.13	3.36	-----
1895	1.09	0.90	3.25	3.20	2.85	4.01	3.55	1.31	0.00	0.99	0.94	1.50	23.59
1896	0.90	3.57	4.63	2.04	5.65	4.23	13.65	1.37	5.32	1.37	3.33	2.55	48.61
1897	2.80	4.20	3.48	2.77	3.73	3.49	5.13	5.23	1.67	1.37	5.84	4.93	44.64
1898	7.69	3.21	5.69	4.25	5.76	3.36	3.76	7.01	1.87	4.47	2.06	3.99	53.12
1899	2.33	4.40	5.71	1.65	6.44	6.24	2.03	2.06	3.05	0.39	0.89	2.73	37.82
1900	1.97	3.29	3.15	1.41	2.63	4.62	4.49	3.65	0.40	2.26	5.68	2.66	36.21
1901	6.22	1.80	2.03	6.04	5.40	3.88	3.33	4.74	1.76	0.87	3.75	4.39	44.21
1902	3.75	4.18	3.66	4.83	4.76	4.96	3.35	3.70	2.92	4.52	2.50	7.09	50.22
1903	4.65	5.23	3.72	3.26	4.35	6.55	6.24	a3.10	1.10	2.55	2.60	1.77	45.12
1904	3.16	1.90	-----	3.89	3.83	5.17	5.07	1.95	1.50	1.98	-----	-----	-----
1905	3.69	-----	-----	1.75	4.58	5.73	5.27	1.85	1.43	3.38	1.42	2.41	-----
1906	a4.12	1.33	4.88	4.37	2.04	9.35	2.65	3.38	3.38	2.09	1.70	6.94	46.23
1907	7.00	3.13	7.05	3.89	4.59	4.89	7.51	4.07	3.72	2.98	3.47	4.29	56.59
1908	4.00	4.47	7.34	4.63	9.65	2.38	4.40	3.50	0.84	0.67	0.78	3.68	46.34
1909	3.60	5.27	4.60	6.16	3.22	7.98	3.46	4.65	3.05	3.51	1.06	3.89	50.45
1910	4.90	3.72	0.57	3.22	4.09	5.95	2.31	2.61	3.43	1.31	3.27	3.60	38.98
Mean	3.87	3.37	4.27	3.62	4.59	5.17	4.76	3.39	2.21	2.18	2.53	3.74	44.46

a. Estimated from surrounding stations.

Derry, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.11	2.95	1.53	-----
1897	2.10	5.11	4.89	3.81	4.03	1.99	4.99	3.40	2.62	0.44	5.76	3.96	43.10
1898	5.69	1.98	5.82	2.15	4.34	4.58	2.51	6.29	1.43	4.84	3.21	2.83	45.67
1899	4.25	3.74	4.91	2.55	3.57	4.92	4.50	5.06	2.95	0.72	4.29	3.27	44.73
1900	3.09	3.83	3.41	1.81	2.34	5.28	5.84	1.85	0.84	3.56	6.33	2.77	40.95
1901	3.55	1.73	4.49	8.41	7.26	4.27	4.48	-----	-----	-----	-----	5.12	-----
1902	4.18	3.38	4.00	4.97	1.38	6.25	7.28	3.53	2.79	5.17	1.30	4.86	49.09
1903	2.81	4.86	4.02	3.91	1.64	5.04	5.92	5.19	1.03	3.02	2.72	1.62	42.38
1904	3.09	3.50	5.26	4.74	2.96	3.34	6.21	2.93	1.45	2.56	0.48	2.58	39.10
1905	3.54	1.98	4.26	3.28	4.56	7.93	5.89	5.26	2.92	4.43	2.87	4.27	51.19
1906	2.67	1.35	3.79	2.29	2.32	8.09	4.86	4.03	1.83	2.88	1.09	4.56	39.76
1907	6.83	2.04	7.11	2.63	2.23	5.99	6.13	2.93	5.28	2.67	2.88	3.49	50.21
1908	2.42	3.51	8.01	4.60	6.20	4.61	4.45	3.14	0.76	0.28	0.81	3.19	41.98
1909	2.54	4.53	4.03	6.31	2.86	3.37	2.50	3.21	1.55	2.73	0.99	2.24	36.86
1910	7.39	3.27	0.44	3.41	2.79	2.65	2.25	1.79	3.52	1.98	2.22	2.84	34.57
Mean	3.86	3.20	4.60	3.92	3.46	4.88	4.84	3.74	2.23	2.74	2.71	3.28	43.05

Dubois, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1891	3.02	5.98	3.08	2.66	1.71	6.90	5.75	4.61	1.95	3.68	4.07	4.88	48.29
1892	3.72	3.47	3.66	2.90	7.31	5.76	4.14	2.57	1.59	0.92	3.92	1.66	41.62
1893	3.17	7.50	2.70	4.34	4.66	4.10	3.90	3.73	2.61	2.33	2.60	3.47	45.11
1894	3.52	2.47	1.96	3.79	7.98	3.41	2.15	0.74	7.72	2.74	2.27	3.22	41.97
1895	4.83	1.58	1.95	4.41	2.24	5.24	2.29	2.54	1.60	0.76	3.37	3.73	34.54
1896	1.38	3.68	3.87	2.58	1.86	5.22	7.46	3.79	5.21	3.05	3.67	1.98	43.72
1897	2.18	2.83	4.23	3.45	4.11	2.48	6.57	2.23	3.38	-----	-----	-----	-----
Mean	3.12	3.93	3.06	3.31	4.27	4.73	4.61	2.89	3.44	2.25	3.32	3.16	42.54

Elkins, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1894	4.23	7.48	2.38	5.30	5.88	4.02	2.53	3.15	2.08	3.00	2.77	6.56	49.38
1895	4.61	0.30	4.33	4.74	4.27	4.36	5.30	4.50	2.61	2.25	1.54	2.99	41.80
1896	1.63	5.53	6.41	3.17	5.50	5.04	15.10	3.26	5.68	2.20	3.92	2.88	60.32
1897	2.85	7.24	2.73	2.79	4.71	5.24	9.92	4.15	2.15	0.52	5.21	6.03	53.54
1898	7.92	2.87	7.08	3.44	6.15	2.76	8.33	10.06	2.30	6.29	4.74	4.13	66.07
1899	4.26	4.04	5.12	2.69	6.12	5.98	5.87	1.43	5.01	1.15	2.04	3.64	47.35
1900	2.07	3.88	4.41	1.37	2.51	5.93	5.59	2.61	2.56	2.46	5.93	3.05	42.37
1901	3.65	1.17	3.50	3.61	5.95	5.94	2.98	4.23	3.14	0.50	2.90	6.92	46.49
1902	3.90	2.86	4.39	3.61	4.08	5.22	6.23	3.61	4.81	2.76	3.92	5.88	51.27
1903	3.79	5.72	3.64	3.38	5.37	5.51	3.60	2.48	1.69	1.79	2.71	2.16	41.84
1904	2.75	3.18	4.25	3.06	3.60	5.25	4.07	4.59	1.70	2.16	1.02	3.19	38.82
1905	3.48	2.32	4.89	2.96	5.41	3.93	4.56	3.97	1.83	3.70	2.30	2.29	41.64
1906	3.84	1.24	5.38	5.29	3.66	6.46	3.16	4.84	4.24	3.81	2.10	5.07	49.09
1907	8.93	2.87	4.75	3.90	3.21	7.26	11.10	5.27	7.10	3.73	3.84	3.41	65.37
1908	4.02	3.22	5.58	4.95	8.42	2.77	7.88	2.60	0.88	0.33	0.77	2.83	44.25
1909	2.98	3.20	3.28	5.39	2.96	7.78	4.85	3.20	4.30	4.58	2.31	2.02	46.85
1910	5.77	2.22	0.68	2.24	3.91	8.05	4.07	2.70	3.61	2.21	2.26	2.72	40.44
Mean	4.16	3.48	4.27	3.64	4.81	5.39	6.18	3.92	3.27	2.55	2.96	3.87	48.61

Note: The above table includes Beverly, 1894 to 1898, inclusive and Elkins, 1899 to 1910, inclusive.

Elwood Junction, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	1.46	1.35	3.48	2.63	3.05	5.67	5.70	2.79	1.50	3.16	1.12	4.21	36.12
1903	1.50	3.54	4.50	2.16	4.12	6.28	6.24	4.10	1.06	2.58	2.02	2.18	40.28
1904	3.20	2.52	5.24	5.66	2.94	6.29	3.00	3.49	1.85	1.68	0.64	2.47	38.98
1905	1.72	2.35	3.66	2.96	3.54	5.48	4.34	1.92	3.38	4.67	2.16	3.32	39.50
1906	2.13	1.26	3.18	2.38	2.46	3.04	6.26	6.64	3.17	3.76	1.58	3.15	39.01
1907	5.52	0.98	6.18	4.30	4.84	4.94	2.38	1.40	5.60	2.39	1.74	3.02	43.29
1908	1.80	3.46	6.50	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	2.47	2.21	4.68	3.35	3.49	5.28	4.65	3.39	2.76	3.04	1.54	3.06	39.53

Station discontinued March 31, 1908.

Erie, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1873	-----	-----	-----	-----	-----	2.19	5.12	4.83	3.71	5.87	3.53	4.89	-----
1874	5.54	4.01	1.09	1.52	1.94	3.76	7.03	1.99	4.43	2.29	2.51	1.72	37.83
1875	1.41	0.94	2.68	1.69	5.14	5.45	2.41	5.18	3.40	5.04	3.95	3.91	41.20
1876	4.53	5.31	3.76	3.62	2.83	4.70	1.31	0.98	8.45	5.51	2.92	0.75	44.67
1877	2.15	0.33	5.07	2.04	1.30	5.87	3.50	3.34	2.27	4.55	6.27	2.77	39.46
1878	6.20	3.41	5.22	3.28	6.31	3.25	2.73	2.00	7.08	6.83	4.28	4.45	55.04
1879	1.80	2.41	2.99	2.29	1.04	2.33	2.04	4.17	2.91	1.18	8.35	4.84	36.35
1880	2.86	3.73	2.32	3.86	3.02	3.78	3.06	4.01	5.01	3.56	4.45	1.25	40.91

Erie, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1881	2.10	1.93	2.39	1.26	2.16	6.37	1.39	1.02	1.35	5.75	5.46	6.44	37.62
1882	4.00	3.12	4.27	3.31	5.63	3.43	3.80	4.14	4.85	3.17	3.42	3.23	46.37
1883	2.66	5.94	1.25	2.94	6.29	3.73	3.94	2.44	4.41	4.00	3.47	3.74	44.81
1884	4.59	5.88	3.84	1.99	3.42	2.40	5.29	2.16	3.92	3.23	4.91	3.84	45.47
1885	3.60	2.10	1.83	2.25	4.90	6.84	2.03	7.97	3.42	8.17	5.83	3.19	52.13
1886	4.80	3.43	3.03	3.05	1.48	2.77	2.16	1.53	3.26	1.73	6.21	4.04	37.49
1887	3.66	8.50	3.06	2.55	2.96	5.21	0.80	3.54	3.17	4.43	4.13	3.13	45.14
1888	2.79	1.66	2.04	2.70	2.26	2.38	3.17	3.76	2.86	3.17	3.38	1.77	31.94
1889	2.71	1.57	1.73	3.14	2.51	6.02	1.68	2.26	4.85	3.37	3.29	4.03	37.66
1890	4.50	3.60	3.43	3.16	6.40	4.23	0.76	4.64	5.16	6.13	3.32	1.72	47.05
1891	2.32	4.95	2.44	1.34	1.49	1.22	2.66	1.96	2.82	1.78	3.99	3.27	30.24
1892	3.26	2.39	2.20	1.14	8.05	6.48	2.15	6.22	3.19	1.96	3.03	1.60	41.67
1893	2.40	5.85	1.89	3.67	7.99	3.20	1.79	3.61	1.13	3.84	1.97	2.65	39.99
1894	2.07	3.55	1.95	1.74	4.91	2.88	2.26	0.54	5.48	5.35	1.90	2.53	35.16
1895	3.51	1.33	1.64	2.09	2.58	1.75	2.59	3.30	4.01	3.40	4.37	4.98	35.55
1896	1.52	3.97	3.41	1.46	2.63	4.67	5.50	3.47	3.72	2.01	2.90	1.76	37.02
1897	2.57	1.74	2.79	1.55	3.04	3.01	5.81	4.70	0.54	1.24	4.62	2.73	34.34
1898	3.41	2.02	3.24	1.83	2.79	2.87	1.63	4.19	2.62	3.05	3.58	2.84	34.07
1899	1.50	1.44	3.08	1.08	5.35	1.91	2.60	0.07	3.76	2.04	1.31	4.22	28.36
1900	2.61	2.55	2.72	1.60	1.48	3.99	5.56	2.26	1.97	2.06	4.76	1.06	32.62
1901	1.30	1.34	1.99	3.20	2.24	2.48	2.27	5.37	2.99	1.69	2.96	3.84	31.67
1902	1.86	0.56	0.77	2.09	3.32	4.16	5.97	0.51	3.36	3.88	1.34	1.97	29.79
1903	1.49	3.59	2.82	3.81	3.20	4.50	3.57	3.28	1.50	3.70	1.87	2.25	35.58
1904	4.94	2.90	3.32	2.83	3.40	2.33	3.68	2.07	2.78	4.49	0.40	1.82	34.96
1905	2.74	1.27	1.40	2.29	3.97	2.86	3.68	5.08	2.90	3.98	2.51	0.95	33.63
1906	1.09	0.96	2.76	2.33	1.37	4.35	3.83	4.16	2.53	6.33	1.80	3.31	34.82
1907	4.51	0.66	3.34	1.86	3.27	3.69	3.42	1.66	6.72	4.29	1.05	3.41	37.88
1908	1.54	2.65	2.22	3.99	3.22	2.70	2.26	1.32	1.15	1.53	1.84	2.30	26.72
1909	2.44	4.85	2.54	5.15	2.36	2.58	2.46	1.76	3.70	1.59	2.60	1.85	33.88
1910	4.00	4.02	0.53	2.23	3.46	2.01	3.82	1.76	2.57	5.00	3.45	2.89	35.74
Mean	3.00	2.99	2.62	2.48	3.51	3.64	3.15	3.09	3.53	3.72	3.47	2.94	37.97

Fairmont, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	4.00	2.31	2.78	3.56	4.90	3.62	4.39	2.79	2.31	1.02	3.56	2.20	37.44
1893	2.76	5.25	1.05	6.21	3.64	3.97	2.42	2.79	2.20	3.34	2.48	1.82	37.93
1894	2.03	3.53	1.81	3.51	3.45	4.23	2.96	1.57	2.19	2.40	2.38	4.59	34.65
1895	5.81	1.08	4.15	2.76	1.58	4.08	2.69	3.28	1.10	0.84	2.92	2.33	32.62
1896	1.16	2.79	4.48	1.57	5.92	4.59	13.33	2.64	4.41	2.95	3.13	2.29	49.26
1897	1.94	5.47	3.32	3.42	4.46	3.83	3.38	2.60	0.62	0.12	6.35	4.63	40.14
1898	4.99	2.10	6.10	4.40	4.71	3.36	3.10	7.40	2.47	5.81	2.66	2.70	49.80
1899	4.44	3.34	5.67	2.27	5.57	5.59	5.81	3.01	3.68	0.43	3.18	2.87	45.86
1900	2.49	3.42	4.14	1.38	2.99	5.47	5.08	3.45	0.43	4.33	5.59	2.34	41.11
1901	2.52	0.67	3.54	6.68	6.24	5.46	1.91	2.92	4.29	0.38	3.23	6.02	43.86
1902	3.20	2.54	4.18	4.16	2.26	4.30	5.97	2.09	4.34	3.81	3.16	6.74	46.75
1903	2.76	4.94	5.40	3.46	2.62	5.88	6.58	1.74	1.34	2.87	2.70	1.80	42.09
1904	2.56	1.90	4.91	3.14	3.10	6.11	2.89	2.51	1.69	1.78	0.44	2.98	34.01
1905	3.53	1.76	6.26	2.80	4.44	4.10	8.70	5.19	2.81	6.16	2.63	3.90	52.28
1906	4.24	1.62	4.92	4.92	1.59	5.74	3.80	4.26	1.98	2.03	1.87	5.38	42.35
1907	7.70	3.53	5.89	2.71	5.84	4.64	6.83	6.15	3.80	2.59	3.89	3.11	56.68
1908	2.30	3.90	6.61	3.28	5.95	4.04	3.93	2.15	0.97	1.25	0.79	2.67	37.84
1909	3.73	5.63	3.43	6.11	4.51	7.45	3.30	2.18	2.10	2.26	0.72	2.43	43.85
1910	8.01	2.72	0.35	2.17	3.92	4.14	5.53	2.83	4.71	1.50	2.30	2.55	40.73
Mean	3.69	3.08	4.16	3.61	4.08	4.77	4.87	3.23	2.50	2.41	2.84	3.33	42.54

Franklin, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1869	3.77	3.70	4.45	1.57	5.08	5.60	-----	2.88	10.19	1.97	4.52	4.12	-----
1870	7.75	4.07	4.63	2.62	3.82	5.50	11.63	5.96	2.02	4.91	2.35	4.46	59.72
1871	3.38	2.48	3.40	2.27	2.15	3.53	3.49	5.10	0.58	1.65	3.85	2.86	34.74
1872	1.17	1.40	2.66	2.65	2.23	3.47	8.63	4.58	4.19	5.15	2.33	3.05	41.51
1873	3.86	2.69	5.25	4.12	1.71	6.00	7.19	3.19	2.62	7.06	5.29	5.93	54.91
1874	6.14	4.73	3.00	4.87	5.00	3.47	5.65	3.50	3.55	1.00	4.30	2.19	47.40
1875	2.56	1.56	4.56	2.16	3.25	4.62	3.37	5.63	4.63	4.13	3.13	5.25	44.85
1876	4.00	4.19	4.81	3.31	1.75	3.50	4.37	2.50	9.56	2.25	3.19	3.50	46.93
1877	4.83	1.64	6.26	1.20	0.47	6.52	6.72	1.10	3.06	4.06	5.53	2.32	43.71
1878	3.67	2.03	2.08	2.74	2.76	2.91	5.66	0.84	6.71	2.04	3.26	5.42	40.12
1879	3.48	5.11	3.10	1.89	0.86	3.27	3.75	1.55	2.27	1.95	5.41	5.02	37.66
1880	3.64	2.92	2.61	2.21	2.78	4.94	1.83	3.18	2.32	2.40	2.64	2.50	33.97
1881	3.58	3.35	3.32	2.16	2.68	9.33	1.05	0.34	2.16	3.08	3.06	4.96	39.07
1882	3.96	3.02	3.10	1.60	5.02	7.88	2.90	6.25	4.90	2.68	2.04	2.48	45.83
1883	2.22	1.72	0.87	1.80	6.38	7.07	7.17	1.64	2.82	3.10	2.78	3.71	41.28
1884	5.20	4.35	3.66	1.47	2.39	5.54	4.85	3.33	2.64	3.08	1.77	3.72	42.00
1885	4.38	2.88	1.70	2.18	3.70	6.75	2.50	6.22	3.09	4.05	3.33	2.58	43.36
1886	4.86	3.32	3.40	4.24	1.03	4.33	3.96	1.62	3.02	1.20	4.49	3.36	38.83
1887	2.65	9.24	2.57	3.00	3.04	4.04	2.66	5.18	2.44	1.40	2.44	2.16	40.82
1888	4.42	2.08	2.41	2.38	5.80	6.02	4.58	5.52	4.95	4.58	3.98	2.58	49.30
1889	4.12	1.68	1.56	3.10	2.19	5.25	8.86	2.12	4.39	3.10	2.88	4.53	43.78
1890	4.50	4.84	4.78	4.07	9.98	2.96	4.19	4.99	6.60	-----	-----	-----	-----
1897	1.95	2.50	4.91	3.22	3.66	2.90	5.74	5.00	0.77	0.28	5.45	3.20	39.58
1898	4.51	1.48	4.29	1.53	4.08	3.41	2.18	5.87	2.10	4.42	3.89	1.31	39.07
1899	0.82	-----	4.19	1.06	5.28	3.00	4.75	1.77	2.98	2.58	0.61	3.77	-----
1900	1.94	3.39	2.46	0.60	1.90	2.86	5.35	2.18	3.09	2.31	4.42	1.20	31.70
1901	2.31	1.12	4.51	5.64	4.00	1.72	2.87	7.30	5.66	0.63	2.98	3.51	42.25
1902	2.16	1.59	1.99	1.34	3.76	6.46	8.95	1.19	3.76	2.42	1.95	3.57	39.14
1903	2.00	4.33	-----	3.77	1.98	7.65	6.98	6.02	-----	2.77	2.51	2.07	-----
1904	5.42	3.87	3.75	4.11	6.00	2.14	4.24	4.84	2.35	1.20	0.74	2.11	40.83
1905	2.97	2.07	2.99	2.02	3.11	4.21	8.57	4.89	3.11	4.30	3.57	3.28	45.09
1906	2.29	0.84	3.14	2.36	2.89	5.41	1.78	6.18	4.20	-----	2.57	3.64	-----
1907	4.84	1.63	4.07	3.90	4.59	4.54	4.96	1.06	3.75	3.78	2.65	3.64	43.41
1908	2.70	2.88	4.94	4.73	6.79	3.23	4.73	1.95	1.30	1.60	1.34	4.28	40.47
1909	3.22	5.70	3.09	5.93	3.22	3.92	3.35	2.58	1.42	1.32	1.66	2.42	37.83
1910	7.41	4.25	0.59	3.30	2.83	2.18	3.46	1.50	4.84	3.36	3.11	3.57	40.40
Mean	3.69	3.10	3.40	2.81	3.56	4.61	4.94	3.60	3.66	2.82	3.14	3.38	40.94

No records 1891–1896.

Franklinville, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.18	1.61	-----
1897	2.54	2.01	3.04	2.76	3.40	1.71	5.88	2.63	0.90	0.75	5.00	4.01	34.63
1898	4.78	1.98	3.50	3.32	3.48	4.79	3.24	7.99	2.51	5.46	4.02	2.64	47.71
1899	2.14	1.79	3.26	1.12	3.19	2.65	3.16	1.54	3.84	2.40	1.87	4.38	31.34
1900	3.37	3.38	4.23	1.37	1.91	2.56	5.85	3.68	2.09	3.79	5.60	2.36	40.19
1901	2.29	1.62	3.35	5.05	4.94	2.74	3.61	5.92	3.53	1.32	4.14	5.87	44.38
1902	2.39	2.45	1.92	3.46	3.97	4.68	10.09	2.31	3.40	3.59	1.65	2.75	42.66
1903	3.12	2.80	4.04	3.49	1.58	3.42	4.65	5.20	3.04	3.69	2.68	2.36	40.07
1904	4.48	4.61	4.63	4.03	4.27	2.47	5.33	2.30	5.26	6.11	1.77	3.52	48.78
1905	5.05	1.66	2.77	3.80	2.88	8.89	5.82	4.09	2.10	4.87	4.35	3.32	49.60
1906	2.10	1.05	3.30	2.90	4.76	4.24	2.97	4.71	4.32	5.61	2.22	3.18	41.36
1907	3.19	1.16	2.64	2.76	3.05	5.24	3.60	1.14	4.63	3.80	2.52	2.63	36.36
1908	2.93	4.02	2.78	4.27	5.50	5.63	4.10	2.27	1.21	1.01	1.92	2.22	37.86
1909	2.82	4.71	2.82	4 96	3.23	4.43	2.69	3.63	2.50	4.52	1.53	1.86	39.70
1910	5.46	4.45	0.66	5.07	3.57	1.98	3.95	4.55	3.29	4.46	-----	-----	-----
Mean	3.33	2.69	3.07	3.45	3.55	3.96	4.71	3.71	3.04	3.67	3.03	3.05	41.12

Freeport, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	-----	-----	-----	-----	-----	-----	-----	1.32	2.81	0.30	4.03	1.88	-----
1878	3.74	1.94	2.61	3.51	4.18	3.84	1.35	1.43	3.14	1.71	4.52	4.66	36.63
1879	3.75	2.39	3.13	1.84	0.85	5.25	7.18	3.97	0.86	0.82	2.75	6.46	39.25
1880	3.92	4.01	4.17	2.99	4.02	5.36	2.80	6.12	2.10	2.88	2.56	3.75	44.68
1881	3.89	3.43	4.15	2.24	2.59	5.51	2.03	0.92	1.70	5.35	4.85	6.03	42.69
1882	5.74	3.93	3.71	1.52	7.47	3.79	4.32	5.98	3.35	0.73	2.70	1.86	45.10
1883	3.24	4.96	1.89	4.04	6.63	1.45	-----	-----	-----	-----	2.04	2.98	-----
1884	6.23	5.86	4.28	7.78	3.39	2.12	4.54	1.91	2.46	3.61	1.66	4.77	43.61
1885	4.99	1.87	1.57	2.46	4.38	2.91	5.25	8.77	1.87	4.73	2.86	2.14	43.80
1886	3.71	2.09	3.02	4.72	3.78	4.95	5.68	3.03	5.47	1.20	5.87	2.50	46.02
1887	2.17	6.74	1.53	3.00	2.49	3.93	4.00	4.60	2.11	0.91	1.98	0.95	34.41
1888	7.68	2.20	3.45	2.03	3.33	4.14	-----	-----	-----	3.13	4.00	1.92	-----
1889	2.86	1.90	2.62	4.04	1.80	3.58	8.22	3.19	4.19	2.99	5.37	3.45	44.21
1890	4.89	5.46	4.95	5.76	6.15	3.95	3.32	4.50	5.05	6.48	2.14	5.28	57.93
1891	3.09	7.70	4.26	2.99	1.19	4.19	4.32	3.08	2.54	2.29	3.29	3.45	42.39
1892	4.17	3.17	2.90	1.83	4.81	3.40	3.19	1.87	3.15	0.58	3.52	2.48	35.07
1893	3.32	6.77	1.47	5.65	4.72	3.91	2.88	3.23	2.37	3.99	1.57	3.67	43.55
1894	3.12	3.32	2.28	3.24	4.27	2.27	0.98	0.17	3.91	2.18	2.46	3.98	32.18
1895	4.93	1.24	2.55	2.33	2.39	3.07	2.74	3.18	0.98	0.47	3.68	3.27	30.83
1896	1.64	3.08	4.20	2.24	4.43	3.90	7.79	2.66	4.73	2.42	3.58	1.84	42.51
1897	2.02	3.99	5.05	4.29	3.65	3.46	8.08	2.69	2.53	0.29	6.42	3.84	46.31
1898	5.68	2.30	6.72	1.82	3.39	3.98	3.25	6.31	1.62	5.06	3.43	2.76	46.32
1899	3.27	3.46	5.84	1.77	4.84	3.54	3.34	3.48	2.09	1.12	3.62	3.27	39.64
1900	2.66	3.59	3.78	1.33	1.69	4.33	6.66	2.27	1.03	3.78	5.00	1.76	37.88
1901	2.99	0.97	4.52	8.93	7.81	7.13	2.92	7.87	2.44	0.64	3.13	4.38	53.73
1902	1.96	1.25	4.63	3.58	3.38	5.22	5.14	2.43	2.90	3.35	1.32	5.78	40.94
1903	3.37	4.75	4.95	2.70	2.22	4.80	3.65	6.07	1.08	3.05	2.91	2.55	42.10
1904	3.35	2.73	6.05	4.60	3.87	5.43	4.26	3.39	2.38	1.77	0.86	3.01	41.70
1905	2.79	2.00	2.52	3.12	2.92	5.77	7.13	3.29	3.50	3.78	2.98	4.21	44.01
1906	2.83	1.34	3.88	2.47	3.57	5.36	6.84	5.00	3.13	3.80	1.72	3.57	43.51
1907	6.67	1.30	6.68	2.74	3.44	3.41	2.87	2.48	4.17	2.81	2.27	3.91	42.75
1908	2.70	3.43	6.53	4.41	7.49	3.22	6.01	2.13	1.26	0.91	1.02	4.01	43.12
1909	3.72	5.99	4.02	6.35	3.11	3.25	2.82	1.98	1.76	2.16	1.34	2.99	39.49
1910	7.12	4.03	0.58	3.51	4.05	3.80	2.72	1.81	6.47	2.03	2.55	2.85	41.52
Mean	3.88	3.43	3.77	3.51	3.89	4.07	4.40	3.47	2.79	2.46	3.06	3.41	42.20

Friendship, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1867	-----	-----	-----	-----	-----	1.90	2.45	1.42	2.81	-----	1.29	-----	-----
1876	-----	-----	-----	-----	-----	-----	-----	0.95	5.27	1.23	2.89	1.90	-----
1877	3.80	0.50	2.80	0.30	0.45	4.27	3.47	0.67	2.40	4.63	0.95	1.12	25.36
1878	7.16	1.25	0.90	2.43	2.62	4.27	3.25	-----	1.33	4.95	4.44	4.66	-----
1879	2.35	2.78	1.28	1.55	1.50	7.45	3.13	2.87	1.60	2.15	4.18	2.58	33.42
1880	2.28	3.57	2.04	3.93	2.57	4.31	1.39	3.21	2.12	2.87	2.02	1.63	31.94
1881	3.38	1.26	4.40	1.06	1.59	5.63	1.65	1.48	1.50	3.88	5.42	5.95	37.20
1882	2.27	3.90	4.35	1.20	5.61	5.04	3.03	1.52	1.60	-----	2.90	-----	-----
1883	0.92	5.35	1.68	3.35	6.80	4.97	5.82	2.30	2.09	2.27	-----	-----	-----
1884	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.15	-----
1887	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.10	1.80	-----
1888	1.10	1.12	2.58	9.85	0.21	3.15	1.41	4.73	1.02	4.10	1.52	3.25	34.04
1889	4.25	2.45	4.85	4.53	6.60	4.92	4.30	2.83	-----	-----	-----	-----	-----
1893	1.16	4.96	2.33	4.34	5.70	2.04	2.01	5.33	3.65	3.07	2.12	3.51	40.22
1894	4.26	3.17	1.73	5.81	9.19	3.37	3.99	2.41	6.89	3.50	1.92	2.15	48.39
1895	3.03	1.34	1.01	1.96	2.39	4.91	2.72	3.74	3.02	1.44	3.44	3.35	32.35
1896	2.03	3.23	3.45	1.58	3.09	3.22	4.54	1.83	5.65	4.03	2.29	1.40	36.34
1897	2.29	1.56	3.59	2.77	2.65	2.93	4.47	-----	-----	-----	-----	-----	-----
1909	-----	-----	-----	-----	-----	4.43	2.69	3.63	2.50	4.52	1.53	-----	-----
Mean	2.88	2.60	2.64	3.33	3.64	4.06	3.15	2.60	2.90	3.28	2.53	2.73	35.47

No records 1868-1875, 1885-1886, 1890-1892 and 1898-1908.
Station discontinued November, 1909.

Glenville, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1887	-----	-----	-----	-----	-----	-----	-----	1.56	2.89	1.15	0.96	1.74	-----
1888	4.30	2.43	3.43	2.37	6.03	3.84	7.36	7.61	5.06	5.82	2.77	1.62	52.64
1889	3.42	2.68	1.49	4.12	5.13	4.51	9.61	1.89	4.89	3.08	7.19	2.45	50.46
1890	4.35	6.97	7.54	4.08	5.46	4.85	5.11	7.72	6.67	6.96	2.89	6.04	68.64
1891	4.72	5.67	4.51	3.46	2.01	7.01	6.87	6.14	1.63	2.39	4.35	3.88	52.64
1892	3.81	2.70	3.24	4.78	5.85	4.81	2.92	2.99	4.49	0.98	3.37	2.49	42.43
1893	2.62	4.66	1.44	5.87	3.84	4.18	3.13	3.56	2.19	5.23	3.22	1.92	41.86
1894	2.48	4.34	1.93	4.39	5.22	3.88	2.60	2.05	2.12	2.31	2.73	5.02	39.07
1895	4.90	1.25	4.50	3.69	1.66	1.86	4.54	1.69	3.74	0.50	2.77	3.24	34.34
1896	2.13	3.63	5.13	1.40	2.32	6.11	14.15	2.17	5.89	3.74	3.86	2.24	52.77
1897	1.58	7.49	3.57	3.36	5.31	6.40	8.93	3.36	1.61	0.15	6.00	4.53	52.29
1898	6.61	2.82	7.58	3.02	4.01	3.80	4.41	7.73	3.89	4.91	3.03	3.81	55.62
1899	6.04	4.51	7.80	2.72	3.27	6.50	4.34	1.74	4.25	0.97	1.97	3.68	47.79
1900	2.71	5.24	3.68	1.35	4.30	4.98	4.36	2.39	0.94	3.52	4.59	2.81	40.87
1901	3.11	1.36	3.26	8.76	5.49	5.05	2.93	5.34	3.55	0.70	3.48	6.54	49.57
1902	4.26	3.85	4.28	3.39	4.17	5.35	5.52	3.86	3.23	3.67	3.32	7.29	52.19
1903	3.64	6.39	4.78	4.66	4.13	4.52	2.69	2.25	1.10	2.79	3.01	3.25	53.21
1904	2.81	3.12	4.99	3.50	2.00	4.75	1.50	2.32	0.84	1.00	0.47	2.95	30.25
1905	4.05	3.77	5.06	3.33	6.15	1.97	3.92	5.20	1.98	7.55	2.58	3.08	48.64
1906	4.44	2.68	5.81	3.39	1.51	5.06	3.91	3.80	2.30	1.86	2.93	5.82	43.51
1907	7.45	2.30	4.45	3.79	4.26	6.07	8.54	5.81	5.14	2.36	2.25	3.98	56.40
1908	1.72	4.04	5.64	2.76	6.23	3.54	4.47	1.43	1.93	1.38	1.01	3.11	37.26
1909	3.54	4.94	2.58	4.95	3.80	3.95	4.31	4.60	3.06	3.23	1.69	2.96	43.61
1910	6.96	4.49	0.87	3.02	4.62	4.22	3.41	1.03	4.76	1.96	2.31	3.28	40.93
Mean	3.98	3.97	4.24	3.75	4.21	4.66	5.20	3.68	3.26	2.84	3.03	3.66	47.26

Grafton, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	4.69	2.87	2.57	4.56	5.37	2.67	3.32	1.87	3.39	1.45	3.91	3.00	39.67
1893	2.57	4.73	1.13	7.17	4.07	4.06	3.68	1.76	1.51	2.95	2.59	1.71	37.93
1894	2.51	3.84	1.82	4.13	3.98	2.96	4.34	3.05	1.73	2.32	2.40	4.74	37.82
1895	4.67	1.24	3.80	4.15	1.65	4.58	3.65	3.48	0.44	1.61	2.27	2.23	33.77
1896	1.50	2.96	4.70	2.18	4.84	4.01	11.91	2.22	4.68	2.83	3.38	2.00	47.21
1897	2.21	5.27	3.43	3.10	4.81	5.15	6.24	2.82	0.65	0.32	4.89	4.96	43.85
1898	5.58	2.45	7.14	4.05	4.73	4.48	4.36	6.85	1.87	4.92	3.34	2.48	52.25
1899	4.87	3.43	5.51	1.84	4.71	6.33	4.68	2.10	4.74	1.21	3.34	3.22	45.98
1900	2.17	3.95	3.77	1.66	2.72	5.40	5.09	5.40	0.98	3.63	6.18	2.55	43.50
1901	2.53	0.73	3.63	6.51	6.50	9.37	3.32	5.30	3.56	0.43	3.12	4.44	49.44
1902	3.82	2.38	5.14	3.50	5.02	5.68	4.83	4.80	4.68	2.92	3.11	6.86	52.74
1903	2.57	5.65	5.77	3.70	3.74	4.96	3.75	2.28	1.49	3.42	3.62	2.28	43.23
1904	2.54	2.22	5.36	3.77	2.60	4.94	1.60	3.45	2.94	1.55	0.30	2.93	34.20
1905	3.28	1.44	5.78	4.13	4.81	5.05	7.92	5.57	2.34	5.08	2.85	3.15	51.40
1906	3.27	1.61	5.57	5.05	2.99	4.76	2.30	3.07	2.67	2.98	2.56	5.59	42.42
1907	7.70	2.98	5.43	2.41	5.12	4.40	8.01	5.61	5.94	4.09	3.92	3.38	58.99
1908	2.23	3.66	6.65	3.26	7.65	2.87	4.48	2.29	0.74	0.50	0.70	2.94	37.97
1909	3.80	4.82	2.76	5.09	-----	-----	-----	3.18	2.64	3.45	1.23	2.52	-----
1910	9.02	4.80	0.38	2.94	3.78	4.17	5.15	2.01	4.41	2.64	3.57	3.94	46.81
Mean	3.76	3.21	4.23	3.85	4.39	4.77	4.92	3.53	2.71	2.54	3.01	3.42	44.40

Grantsville, Md.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1894	-----	-----	-----	-----	-----	-----	-----	1.62	2.87	2.95	2.32	3.86	-----
1895	5.42	1.45	3.10	4.18	2.28	4.07	4.68	2.27	1.53	1.22	1.00	2.96	34.16
1896	1.81	4.77	5.12	2.98	4.07	5.88	10.17	1.90	5.85	2.61	3.37	2.22	50.75
1897	3.97	7.53	3.52	2.99	3.86	2.72	6.16	2.04	2.27	0.55	6.20	4.11	45.92
1898	6.53	2.06	6.98	3.42	3.94	3.07	7.77	8.93	1.51	5.34	3.24	2.73	55.52
1899	1.93	3.27	5.24	2.21	6.73	3.67	3.15	2.57	3.77	2.37	2.13	2.85	39.89
1900	1.86	3.88	4.14	1.05	1.67	4.09	5.61	2.50	0.87	1.92	5.89	2.52	36.00

Grantsville, Md.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	2.52	0.80	4.99	6.08	8.32	2.79	2.63	4.34	2.24	0.76	2.56	6.87	44.90
1902	3.58	3.83	4.99	4.34	3.64	5.91	4.19	2.65	3.15	4.00	1.85	5.72	47.85
1903	3.60	6.06	4.19	4.19	2.79	6.43	4.58	3.33	1.80	2.61	2.16	1.83	43.57
1904	4.10	2.40	2.34	2.66	2.89	2.71	1.93	1.97	1.05	1.65	0.46	2.73	26.89
1905	3.75	1.80	2.66	1.71	2.18	3.38	4.20	4.31	2.37	4.16	1.90	3.42	35.84
1906	4.09	0.85	5.40	2.95	1.99	4.27	4.82	9.46	2.07	1.98	1.72	5.63	45.23
1907	6.56	3.04	7.50	2.76	4.16	5.40	7.07	3.89	3.93	2.18	4.60	5.15	56.30
1908	2.30	5.00	5.96	4.16	10.41	2.69	5.44	3.36	0.60	0.53	0.80	2.73	43.98
1909	2.90	3.92	2.31	5.39	2.87	4.00	1.25	6.67	2.70	4.09	0.83	5.62	42.55
1910	4.90	2.61	0.42	3.94	4.06	5.43	a2.55	1.89	2.90	1.44	3.40	3.21	36.75
Mean	3.74	3.33	4.30	3.44	4.12	4.16	4.76	3.75	2.44	2.37	2.61	4.01	42.88

a. Estimated from surrounding stations.

Greensboro, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	2.47	3.28	2.64	2.58	4.63	6.79	4.37	3.95	3.04	2.87	7.50	2.56	46.68
1890	5.10	5.25	5.19	3.75	9.23	5.38	4.05	6.05	8.03	8.05	2.14	2.93	65.15
1891	3.19	6.18	3.97	2.11	4.86	6.86	6.10	3.29	2.82	2.95	3.24	3.57	49.14
1892	2.87	2.20	3.21	2.77	5.28	5.39	4.96	1.86	2.01	0.83	3.28	1.51	36.17
1893	2.67	5.00	0.86	5.04	4.96	1.58	2.04	3.19	1.18	2.84	2.03	2.37	33.76
1894	2.33	3.07	2.36	3.31	4.56	2.49	3.81	1.94	3.73	2.16	2.31	3.67	35.74
1895	4.34	1.08	2.92	3.88	1.55	3.93	5.25	4.17	0.55	0.92	3.12	2.83	34.54
1896	1.51	3.21	4.10	2.69	3.36	5.26	12.71	1.93	4.20	3.20	3.13	1.40	46.71
1897	1.86	4.86	3.54	3.98	4.93	4.15	4.42	1.86	0.65	-----	5.36	4.86	40.47
1898	4.95	2.06	6.05	4.06	3.67	4.42	3.95	6.71	1.50	5.79	2.66	2.81	48.63
1899	3.97	3.60	5.47	1.14	5.16	5.70	6.25	1.88	8.30	1.18	3.72	3.53	49.90
1900	2.21	3.57	4.82	1.56	2.96	6.07	7.15	2.86	1.44	3.58	6.59	1.72	44.53
1901	1.83	0.43	2.62	7.09	7.00	5.88	2.59	3.66	4.59	0.27	2.74	5.64	44.34
1902	2.26	1.55	3.72	3.77	3.11	5.48	7.06	2.02	2.58	3.79	1.45	5.02	41.81
1903	1.52	5.31	4.32	4.93	3.02	5.94	5.56	4.04	1.36	3.18	1.89	1.12	42.19
1904	2.08	2.26	4.72	3.46	3.81	3.95	6.06	2.58	1.20	1.36	0.20	2.46	34.14
1905	2.76	1.54	5.10	3.99	2.54	6.04	5.97	3.76	1.70	4.86	2.94	4.29	45.49
1906	3.54	1.50	4.24	3.02	2.78	5.33	2.22	3.02	1.80	3.38	1.41	4.40	36.64
1907	7.60	1.84	6.60	1.56	3.61	4.62	8.82	3.66	3.82	2.82	3.28	2.66	50.89
1908	2.29	3.08	5.88	3.52	5.88	2.50	4.50	2.44	2.38	0.68	0.88	2.51	36.54
1909	3.42	4.12	2.30	4.72	2.95	6.44	1.94	2.41	0.83	2.72	0.69	2.02	34.56
1910	6.42	2.58	0.33	2.28	2.88	5.86	4.18	1.60	4.72	1.16	2.14	a2.87	37.02
Mean	3.27	3.07	3.86	3.42	4.22	5.00	5.18	3.13	2.84	2.64	2.85	3.03	42.50

a. Estimated from surrounding stations.

Greensburg, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1908	-----	-----	-----	4.39	5.88	1.54	3.06	1.87	0.70	0.57	0.84	2.99	-----
1909	3.10	3.99	3.50	5.58	2.84	4.49	3.06	2.39	2.28	3.14	0.62	2.05	37.04
1910	6.58	3.13	0.33	3.18	2.84	3.87	2.71	2.56	3.94	1.44	1.80	3.70	36.08

Greenville, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1888	3.50	1.63	1.92	2.73	2.63	3.44	3.95	3.18	4.07	3.16	5.17	1.61	36.99
1889	3.52	1.18	-----	2.50	2.57	3.51	1.04	1.83	3.68	2.74	2.72	3.03	-----
1890	4.58	5.02	5.12	4.57	-----	3.44	2.52	4.28	6.19	6.85	2.92	2.68	-----
1891	1.22	2.50	3.33	1.75	3.31	6.72	-----	-----	-----	-----	-----	-----	-----
1894	2.23	1.62	1.94	2.55	3.03	1.78	3.32	0.54	6.03	0.65	2.47	2.27	28.43
1895	3.50	1.08	-----	2.35	2.75	3.26	-----	-----	-----	-----	-----	-----	-----

Greenville, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1897	-----	-----	5.63	2.93	4.10	3.55	8.16	4.88	1.91	0.47	5.89	4.73	-----
1898	6.84	3.27	5.53	2.04	3.59	3.60	3.08	5.42	1.76	3.80	-----	-----	-----
1903	2.75	5.42	5.10	4.11	2.09	7.21	7.32	4.73	1.48	4.10	2.78	2.87	49.96
1904	5.03	3.36	4.37	3.45	5.04	4.68	5.59	4.11	2.59	1.37	1.07	2.16	42.82
1905	2.89	2.20	2.93	3.56	4.06	5.63	9.78	4.10	2.81	5.52	1.90	2.37	47.75
1906	1.56	1.59	3.51	2.36	3.08	2.41	3.72	5.79	3.69	5.20	2.04	2.09	37.04
1907	6.18	1.62	4.27	2.80	3.81	6.79	6.48	1.68	4.07	3.71	2.94	3.36	47.71
1908	2.62	4.08	5.20	3.94	4.01	3.80	6.76	2.19	0.91	1.07	1.01	3.51	39.10
1909	4.00	4.52	3.19	4.95	3.54	5.58	1.18	1.39	1.30	2.11	2.49	2.48	36.73
1910	5.47	3.77	0.24	3.92	4.49	1.33	3.04	1.45	5.35	4.35	3.61	3.21	40.23
Mean	3.73	2.86	3.74	3.16	3.47	4.17	4.71	3.25	3.27	3.22	2.85	2.80	40.68

No records July, 1891, to Dec., 1893, July, 1895, to Feb., 1897, or Nov., 1898, to Dec., 1902.

Grove City, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1907	4.51	1.02	6.22	4.17	2.76	3.04	4.53	1.08	4.01	2.46	1.97	3.08	38.85
1908	1.80	3.25	6.27	5.73	3.83	2.39	9.42	1.95	0.98	1.61	0.97	3.71	41.91
1909	3.62	4.84	3.19	5.96	3.57	4.45	2.68	1.72	0.91	1.26	1.39	2.36	35.95
1910	7.71	4.53	0.39	3.80	4.69	2.53	2.83	2.09	6.28	2.83	2.08	2.96	42.72
Mean	4.41	3.41	4.02	4.91	3.71	3.10	4.81	1.71	3.05	2.04	1.60	3.03	39.86

Haskinville, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1895	3.01	-----	-----	-----	-----	-----	3.14	4.09	2.19	1.56	3.35	3.13	-----
1896	2.16	3.41	2.43	0.64	1.72	3.19	5.46	1.86	4.84	3.80	1.46	0.99	31.96
1897	1.56	0.63	2.46	2.25	3.06	1.88	5.56	1.89	2.73	0.68	2.90	2.10	27.70
1898	2.29	1.41	1.98	2.71	3.33	3.95	4.77	4.81	1.77	5.81	2.97	1.37	37.17
1899	0.99	0.75	1.74	0.40	3.58	0.48	3.70	1.85	2.68	2.15	2.52	3.19	24.03
1900	1.48	2.19	2.97	1.60	2.17	2.61	3.63	1.71	1.46	4.07	5.31	1.10	30.30
1901	1.60	0.40	1.86	4.58	6.58	3.06	3.31	5.67	2.66	1.03	2.45	4.05	37.25
1902	1.50	1.26	1.24	1.80	2.55	5.30	9.27	1.80	1.77	2.76	1.37	1.90	32.52
1903	1.68	0.72	5.46	2.16	1.63	6.26	2.96	4.97	2.22	3.19	2.25	1.21	34.71
1904	2.79	1.74	3.37	2.03	3.99	2.87	4.83	3.00	3.19	2.47	0.53	2.00	32.81
1905	2.58	1.25	1.63	2.20	1.26	4.92	8.52	2.92	3.35	3.23	2.08	2.39	36.33
1906	1.01	0.61	3.37	2.22	4.17	4.73	3.44	6.09	2.86	3.63	2.12	2.07	36.32
1907	3.16	0.65	1.97	3.62	2.04	4.05	3.66	1.11	5.05	3.45	2.96	2.59	34.31
1908	1.75	1.98	1.63	3.53	5.58	3.13	3.65	4.40	1.30	1.89	1.61	1.48	31.93
1909	1.45	3.10	1.97	3.35	2.53	3.14	1.31	2.82	2.71	2.33	1.57	1.46	27.74
1910	3.47	3.12	0.39	6.49	4.05	1.60	3.92	2.85	3.35	2.01	2.39	1.60	35.24
Mean	2.03	1.55	2.30	2.64	3.22	3.41	4.45	3.24	2.76	2.75	2.37	2.04	32.69

Herr Island Dam, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1903	2.62	3.82	5.11	3.15	1.82	4.48	3.71	4.65	1.10	2.67	2.98	1.57	37.68
1904	2.62	2.13	5.44	3.37	2.88	6.67	3.78	3.00	2.79	1.93	0.22	2.01	36.84
1905	2.50	1.43	3.15	2.52	3.08	7.09	3.19	3.46	2.75	3.47	2.66	3.40	38.70
1906	2.15	1.22	3.60	1.91	2.01	4.60	5.85	3.33	3.24	3.35	1.20	2.61	35.07
1907	5.27	1.19	5.63	2.06	2.34	3.88	5.04	1.78	3.66	1.94	2.02	3.01	37.82
1908	1.84	3.45	5.43	3.21	4.86	1.52	5.11	2.63	0.77	1.07	0.52	2.49	32.90
1909	2.96	4.68	3.48	5.04	2.16	5.59	1.55	2.90	0.91	2.34	0.85	2.33	34.79
1910	5.56	3.85	0.47	2.61	2.87	2.51	2.16	2.40	5.28	1.62	1.55	2.80	33.68
Mean	3.19	2.72	4.04	2.98	2.75	4.54	3.80	3.02	2.56	2.30	1.50	2.53	35.93

Humphrey, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1883	-----	-----	-----	-----	-----	4.53	6.69	2.55	2.85	3.33	3.02	2.64	-----
1884	2.14	3.62	3.50	2.14	5.11	7.02	5.27	4.80	4.82	3.93	2.93	3.69	48.97
1885	2.51	1.57	1.39	2.86	4.99	5.96	2.38	10.11	4.44	4.17	2.71	3.31	46.40
1886	2.35	1.70	2.57	2.28	3.35	2.76	4.96	2.57	3.91	1.55	6.23	2.67	36.90
1887	4.06	7.30	2.29	3.10	1.50	2.14	2.53	3.37	3.09	3.96	2.29	2.60	38.23
1888	3.51	1.74	1.80	4.14	4.63	3.57	2.42	4.09	3.55	4.27	2.60	2.81	39.13
1889	3.16	1.03	2.34	4.26	6.27	8.85	3.16	1.63	3.12	2.40	4.51	4.98	45.71
1890	5.02	3.91	3.34	4.95	9.11	3.76	3.43	5.31	9.00	5.94	3.81	1.91	59.49
1891	1.82	4.55	2.36	2.17	1.45	5.95	7.22	6.63	2.04	2.42	4.09	4.38	45.08
1892	3.39	3.45	3.45	1.48	7.46	6.43	4.88	4.45	2.55	3.65	4.02	1.95	47.07
1893	2.82	5.52	2.63	5.61	5.42	4.54	3.66	5.82	3.83	4.27	2.56	5.74	52.42
1894	4.41	1.83	2.27	4.53	9.50	4.43	2.45	2.50	8.84	3.37	1.64	1.89	47.66
1895	3.25	1.67	1.54	1.31	1.46	2.83	3.52	3.71	1.90	2.22	4.47	2.82	30.70
1896	2.43	4.83	3.33	1.31	3.35	3.63	7.50	4.49	5.05	3.00	2.93	1.62	43.47
1897	3.06	2.56	2.19	1.39	3.84	3.71	7.77	2.68	1.25	0.60	4.83	3.59	37.47
1898	4.57	2.47	3.87	3.22	3.62	6.87	2.59	9.21	3.22	6.04	3.15	2.82	51.65
1899	1.67	2.50	3.73	1.24	4.21	1.76	4.15	1.26	4.71	2.86	2.60	6.43	37.12
1900	3.70	4.53	4.19	1.89	3.13	2.53	4.48	4.91	1.80	3.69	6.58	2.47	43.90
1901	2.70	2.59	3.56	5.93	4.97	4.17	3.55	4.83	5.10	1.77	4.24	5.97	49.38
1902	2.69	3.53	2.55	3.58	4.28	6.72	9.68	3.38	6.20	3.50	1.50	3.50	51.11
Mean	3.12	3.21	2.78	3.02	4.61	4.60	4.61	4.42	4.06	3.35	3.46	3.21	44.45

No records after 1902.

Hunt, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1904	-----	-----	-----	-----	-----	3.00	5.43	2.02	2.33	2.50	0.80	3.21	-----
1905	3.78	0.40	3.05	2.66	2.37	5.23	8.35	2.13	2.22	1.95	2.12	2.88	37.14
1906	2.35	0.90	3.21	1.51	3.96	2.49	4.49	4.79	3.03	5.15	2.73	2.45	37.06
1907	2.70	0.95	1.89	2.00	2.51	3.20	1.97	0.70	4.52	2.95	1.15	3.10	27.64
1908	2.05	1.70	2.25	2.25	5.90	6.65	5.95	2.08	0.62	0.72	1.17	2.06	33.40
1909	2.98	1.40	1.67	3.75	1.62	2.71	2.41	2.32	3.08	2.26	1.20	1.32	26.72
1910	3.64	3.99	0.68	5.83	3.67	1.19	2.96	3.80	1.97	2.79	2.21	2.70	35.43
Mean	2.92	1.56	2.13	3.00	3.34	3.49	4.51	2.55	2.54	2.62	1.63	2.53	32.90

Indiana, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1903	-----	3.55	4.40	-----	-----	-----	5.36	5.15	1.17	3.96	2.71	-----	-----
1904	3.18	3.10	6.12	4.98	2.95	4.13	4.89	3.45	1.79	2.10	0.90	2.73	40.32
1905	3.37	1.60	3.72	4.74	4.60	4.46	0.29	2.98	3.05	5.45	3.69	3.84	47.79
1906	1.77	0.36	3.59	2.72	3.35	6.04	4.09	6.26	4.08	3.08	1.33	4.65	41.32
1907	5.18	1.45	7.71	2.69	3.38	4.62	3.22	2.16	7.74	3.15	2.47	2.57	46.34
1908	1.74	3.45	6.22	4.92	7.75	3.53	4.96	2.43	0.75	0.29	1.31	4.40	41.75
1909	2.89	4.97	4.90	6.21	2.93	5.93	3.41	1.95	2.22	2.21	1.08	3.14	41.84
1910	5.55	4.05	0.81	3.47	3.85	3.19	3.28	2.99	3.98	1.89	2.80	4.21	40.07
Mean	3.38	2.82	4.68	4.25	4.12	4.56	3.69	3.42	3.10	2.77	2.04	3.65	42.78

Irwin, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	2.08	1.50	3.54	4.23	1.83	6.80	5.62	2.16	3.59	3.87	1.29	4.38	40.89
1903	2.35	-----	5.05	3.42	1.16	6.66	3.73	6.36	1.60	3.36	2.64	1.72	-----
1904	2.74	2.24	4.93	4.64	4.76	4.36	6.81	3.67	1.08	2.82	0.19	2.81	41.05
1905	2.90	1.47	4.36	3.44	3.58	6.05	5.53	5.84	3.15	4.14	2.67	4.53	47.66
1906	2.39	1.16	3.87	2.01	2.39	7.81	4.54	7.25	2.83	3.10	0.81	4.31	42.47
1907	6.49	1.65	5.81	2.56	3.31	5.17	4.83	6.19	5.70	2.36	2.12	3.43	49.62
1908	2.40	3.54	7.58	4.33	3.94	2.89	4.07	1.50	1.15	0.76	0.66	2.63	35.45
1909	2.12	4.02	3.19	5.71	2.66	4.90	1.68	3.48	2.33	3.14	0.70	1.79	35.72
1910	5.99	2.95	0.21	3.07	3.04	2.34	1.83	1.62	4.79	1.68	1.79	2.10	31.41
Mean	3.27	2.32	4.28	3.71	2.96	5.22	4.29	4.24	2.91	2.80	1.43	2.84	40.53

Jamestown, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1850	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	4.45	6.10	-----
1851	4.05	3.97	1.55	3.66	3.91	3.92	11.22	3.43	3.34	4.78	3.18	1.60	48.61
1852	1.35	1.30	3.52	3.92	3.88	4.48	0.58	-----	2.82	2.00	4.88	4.93	-----
1853	2.04	3.55	1.80	5.34	0.96	4.63	4.10	3.75	5.78	3.17	3.10	3.62	41.84
1864	2.72	2.70	1.20	-----	-----	0.50	4.50	9.50	3.80	7.80	3.80	6.00	-----
1865	-----	-----	3.80	4.30	4.30	7.30	6.30	2.30	8.80	1.30	-----	5.10	-----
1866	1.10	4.15	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1871	-----	2.48	3.50	2.00	1.60	3.30	-----	-----	1.30	2.10	2.30	5.45	-----
1872	1.30	1.71	2.07	2.15	3.90	3.40	4.60	2.30	3.10	4.40	3.95	4.00	36.88
1873	3.45	1.70	4.95	1.70	2.50	2.30	4.30	2.70	1.20	5.60	4.70	4.95	40.05
1874	7.10	4.40	2.95	1.75	1.80	3.70	2.50	2.40	4.40	6.70	1.81	1.34	40.85
1875	1.95	2.45	3.85	2.10	3.15	4.42	2.85	8.80	-----	-----	-----	-----	-----
1895	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	4.78	4.53	-----
1896	3.08	5.57	5.21	2.48	3.77	3.39	7.96	3.46	5.48	2.17	3.70	2.63	48.90
1897	4.29	2.23	5.52	3.77	3.45	2.06	5.93	2.95	0.75	0.69	6.52	4.32	42.48
1898	5.55	4.54	3.64	3.39	4.61	5.01	2.18	7.21	2.15	4.90	4.70	4.84	52.72
1899	2.74	3.63	4.62	2.33	4.76	3.29	4.48	2.75	4.83	2.30	1.95	6.99	44.67
1900	6.56	4.15	4.82	2.13	1.95	2.70	4.68	2.02	2.52	3.18	7.27	3.08	45.06
1901	3.98	4.50	2.97	4.85	3.13	3.30	2.50	4.50	4.75	1.57	4.81	4.84	45.70
1902	2.34	1.89	1.90	3.18	3.32	5.23	9.12	2.71	4.18	2.91	1.57	3.62	41.97
1903	2.90	3.00	3.73	3.73	2.37	3.58	5.94	5.32	1.71	3.24	3.95	2.46	41.93
1904	5.03	3.31	4.71	3.75	6.77	2.92	7.47	2.75	5.59	3.53	1.31	2.42	49.56
1905	3.59	1.80	2.54	3.24	3.04	4.81	6.32	4.15	3.01	3.97	3.94	2.83	43.24
1906	1.30	0.77	2.98	2.04	2.98	1.56	2.81	3.29	4.30	6.07	2.33	4.00	34.43
1907	4.17	1.20	3.25	2.70	4.57	4.53	4.32	2.03	5.84	4.67	2.90	3.66	43.84
1908	1.57	3.20	3.35	3.49	5.81	4.34	2.47	2.04	1.29	0.86	2.76	3.43	34.61
Mean	3.28	2.97	3.41	3.10	3.48	3.68	4.87	3.83	3.68	3.54	3.68	4.03	43.55

No records 1854-1863, 1867-1870 and 1876-1894.
Station discontinued December, 1908.

Johnstown, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	0.90	3.77	1.83	2.96	3.65	3.25	3.06	4.06	1.62	5.80	2.72	3.94	37.56
1886	6.48	2.08	3.75	2.96	4.48	7.25	7.10	5.77	5.47	1.70	5.94	2.89	55.87
1887	2.90	10.72	1.26	4.03	0.90	7.72	4.81	4.50	2.42	0.48	2.20	2.47	44.41
1888	8.75	1.86	3.12	3.24	4.74	3.73	4.33	8.34	4.76	0.30	2.00	1.93	47.10
1889	3.11	3.05	2.22	7.60	6.15	-----	-----	3.95	4.59	2.55	5.33	4.62	-----
1890	4.95	5.05	5.74	4.66	6.90	2.72	1.87	6.38	5.85	5.21	2.38	4.89	56.60
1891	3.47	7.99	4.99	2.73	3.44	9.22	6.81	3.87	1.83	2.80	2.51	3.84	53.50
1892	4.14	2.97	3.92	3.55	6.67	5.18	3.70	2.29	1.60	0.88	4.74	2.51	42.15
1893	2.93	7.76	1.45	5.44	6.26	2.02	2.81	2.22	2.26	3.22	2.09	3.59	42.05
1894	3.00	3.32	1.95	3.09	7.03	2.12	1.87	1.20	5.44	2.44	2.55	4.24	38.25
1895	4.91	0.98	2.49	4.38	2.83	4.59	3.02	3.39	3.75	1.24	2.75	3.22	37.55
1896	0.66	2.77	3.80	2.57	1.80	6.03	8.45	4.00	6.03	3.15	3.70	2.04	45.00
1897	2.92	4.05	5.36	3.98	3.71	3.67	5.97	2.23	3.55	0.72	6.14	3.74	46.04
1898	7.57	2.78	6.49	2.04	7.28	4.10	3.89	8.37	2.04	5.89	3.15	3.35	56.95
1899	4.16	3.49	5.37	2.27	6.20	3.62	3.20	5.34	3.45	0.97	4.26	4.25	46.58
1900	3.38	4.63	4.04	1.41	2.92	6.08	4.88	4.41	1.50	2.61	5.84	2.57	44.27
1901	3.52	1.92	4.79	6.06	6.45	6.14	2.00	3.94	3.87	0.73	2.90	5.16	47.48
1902	3.47	2.48	5.09	4.86	2.18	6.73	5.19	2.49	2.31	4.58	1.69	6.11	47.18
1903	4.53	5.80	3.72	4.08	2.36	7.69	4.97	7.21	1.83	3.89	3.02	2.42	51.52
1904	4.10	3.75	5.57	4.45	2.98	3.49	7.45	3.93	2.29	2.84	0.96	3.01	44.82
1905	4.21	2.23	5.06	3.63	4.08	6.78	8.88	5.73	3.90	4.82	3.65	4.42	57.39
1906	3.57	1.30	5.29	2.87	2.60	6.19	4.16	8.19	1.71	2.50	1.56	5.21	45.15
1907	7.29	2.46	7.25	3.59	2.64	5.21	5.39	4.66	5.44	2.65	3.88	4.11	54.57
1908	4.26	6.56	10.00	5.00	5.75	4.17	3.55	3.24	0.51	0.12	0.96	4.61	48.73
1909	3.04	5.31	4.06	6.70	1.97	4.22	3.10	3.50	2.96	3.56	1.06	3.70	43.18
1910	7.81	3.13	1.27	4.28	3.52	3.76	1.23	a2.20	4.79	1.53	1.96	3.31	38.79
Mean	4.23	3.89	4.23	3.94	4.21	4.83	4.30	4.44	3.30	2.58	3.08	3.84	45.10

a. Estimated from surrounding stations.

Lock No. 4, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1886	3.91	0.93	2.32	3.25	4.77	5.56	3.74	3.07	3.94	0.98	4.36	2.92	39.75
1887	1.83	5.39	0.97	3.11	3.16	6.69	6.89	2.25	2.56	3.13	1.82	1.39	39.19
1888	6.13	1.54	3.91	1.59	3.27	2.32	6.09	9.02	3.37	5.01	3.22	1.82	47.29
1889	2.61	1.67	2.56	4.27	5.84	5.67	3.29	2.18	5.01	3.27	5.96	2.77	45.10
1890	5.57	5.04	5.62	3.25	7.80	2.89	4.65	7.39	6.12	6.82	1.77	5.83	62.75
1891	3.21	7.23	4.04	1.77	4.29	4.56	7.00	2.93	2.02	2.12	2.70	3.53	45.40
1892	3.90	2.44	2.24	2.61	4.72	5.14	3.90	1.07	1.83	0.58	3.16	2.16	33.75
1893	2.81	5.43	1.06	4.62	5.19	2.90	2.92	2.42	1.10	3.84	1.35	3.32	36.96
1894	2.34	2.74	1.95	2.95	4.21	2.38	2.52	1.63	4.19	1.36	2.37	3.56	32.20
1895	3.64	0.58	1.82	2.49	1.71	1.94	2.87	2.36	0.55	0.67	3.11	3.14	24.88
1896	2.00	2.67	4.03	2.73	3.30	4.00	12.35	2.37	4.57	3.19	2.66	1.46	45.33
1897	1.53	4.62	2.29	3.33	2.63	2.72	3.72	1.64	1.37	0.07	5.95	3.34	33.21
1898	5.02	1.71	5.64	2.05	3.72	3.02	2.37	7.70	2.99	3.78	2.41	1.98	42.39
1899	3.13	3.26	4.91	1.42	4.38	2.39	6.05	1.48	4.62	0.69	3.54	2.78	38.65
1900	2.25	2.87	3.20	1.74	1.52	2.56	4.92	1.83	0.48	2.77	5.01	1.86	31.01
1901	1.44	0.47	3.43	8.52	5.68	3.96	4.90	2.48	2.70	0.77	1.75	5.22	41.32
1902	2.19	1.39	3.04	3.75	2.05	3.35	7.01	2.52	1.85	4.58	1.14	3.96	36.83
1903	2.77	4.49	4.72	3.01	2.80	6.83	4.59	2.00	2.83	2.91	2.06	1.67	40.68
1904	2.64	2.71	5.68	3.57	3.40	3.79	4.49	2.42	0.82	1.39	0.14	2.35	33.40
1905	2.28	1.60	4.57	2.88	2.46	7.60	5.31	3.05	2.76	3.76	2.50	3.67	42.44
1906	2.39	0.96	3.44	2.66	4.07	5.00	3.74	5.30	1.64	3.81	0.68	3.61	37.30
1907	5.50	1.27	8.20	2.53	3.30	3.81	4.39	3.02	4.85	2.01	1.86	2.82	43.56
1908	1.75	3.87	6.88	3.24	5.10	2.02	2.41	3.33	1.06	0.95	0.74	2.43	33.78
1909	2.59	5.32	3.52	5.40	3.09	5.38	3.05	5.53	1.46	2.59	0.61	1.67	40.21
1910	5.99	3.25	0.37	2.83	2.92	3.57	1.86	3.31	3.63	1.35	1.76	2.73	33.57
Mean	3.18	2.94	3.62	3.18	3.81	4.00	4.60	3.29	2.73	2.49	2.51	2.88	39.23

Lost Creek, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	1.39	2.47	4.07	3.18	4.43	5.53	14.10	2.20	4.90	1.59	2.85	1.97	48.68
1897	1.85	4.65	3.21	3.22	3.54	4.07	7.03	3.59	0.49	0.31	3.78	4.87	40.61
1898	5.55	1.92	7.50	2.93	4.07	1.77	4.47	9.33	2.89	4.89	2.59	2.37	50.28
1899	5.51	4.28	5.59	1.79	6.00	4.17	6.31	2.39	3.37	0.88	2.79	3.75	46.83
1900	2.93	4.79	3.67	1.39	3.08	4.65	4.61	2.50	0.75	3.90	2.54	1.70	36.51
1901	2.13	0.62	3.06	7.48	5.56	2.50	3.33	4.56	3.75	0.12	2.96	5.38	41.45
1902	3.15	2.61	3.07	2.76	3.47	6.55	3.27	2.01	4.80	2.37	2.75	6.88	43.69
1903	2.51	6.51	6.59	4.00	3.17	4.21	2.40	2.14	1.65	2.33	2.91	2.46	40.88
1904	4.26	3.37	3.88	4.39	3.95	4.54	2.00	1.91	0.43	1.80	0.26	2.77	33.56
1905	3.35	2.27	6.34	3.10	7.70	3.41	4.14	4.06	2.43	6.30	2.57	3.36	49.03
1906	4.36	2.33	5.51	5.21	3.12	5.20	2.80	6.45	3.51	1.64	3.02	4.74	47.89
1907	8.04	2.73	4.10	1.97	4.87	3.97	8.68	6.27	3.22	2.34	3.52	4.03	53.74
1908	1.91	3.83	7.73	3.74	9.30	2.72	2.97	3.35	1.21	1.15	1.09	2.86	41.86
1909	3.27	4.50	2.88	5.48	3.39	7.88	5.52	4.03	2.94	3.28	0.93	2.36	46.46
1910	6.32	2.43	0.28	1.66	4.13	3.51	3.99	4.07	5.16	1.55	1.84	2.04	36.98
Mean	3.77	3.29	4.49	3.49	4.78	4.31	5.04	3.92	2.77	2.29	2.43	3.44	43.90

Lycippus, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1893	2.12	5.34	1.43	5.87	5.60	3.75	6.36	1.68	1.57	2.92	1.72	3.51	41.87
1894	3.16	2.31	2.31	3.99	6.71	1.66	3.24	1.09	7.68	2.28	2.45	5.15	42.03
1895	4.66	0.79	2.53	4.46	1.34	3.07	3.82	3.94	1.03	0.76	2.75	2.70	31.85
1896	1.59	3.07	4.17	2.33	2.06	3.98	12.94	4.48	4.59	3.18	3.10	1.31	46.80
1897	2.43	4.70	4.15	3.93	4.08	2.42	2.82	4.52	2.34	0.60	5.41	5.43	42.83
1898	5.33	1.80	6.22	2.25	3.82	2.99	3.83	9.13	2.03	5.04	2.89	3.31	48.64
1899	3.65	3.91	4.62	2.03	5.01	3.91	3.79	3.65	3.63	2.31	1.74	3.22	41.47
1900	2.49	4.34	2.25	1.51	2.30	5.06	6.11	3.51	1.37	2.70	5.35	2.37	39.36

Lycippus, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	2.83	1.15	3.55	8.23	7.17	4.49	3.91	3.19	3.06	0.48	3.02	4.79	45.87
1902	3.83	2.74	3.91	4.20	1.28	6.09	4.79	2.26	2.03	4.12	1.62	5.17	42.04
1903	3.48	4.30	3.42	2.43	1.56	4.55	5.00	3.75	1.53	2.34	2.73	2.48	37.57
1904	3.38	3.22	5.00	2.74	4.26	3.89	5.95	3.76	1.31	1.45	0.32	2.69	37.97
1905	4.58	2.26	4.28	3.89	5.17	7.22	6.24	4.72	2.34	4.92	2.36	3.53	51.51
1906	2.57	1.37	4.00	1.90	2.78	7.82	3.93	8.99	2.14	2.62	1.64	4.65	44.41
1907	6.85	1.69	7.03	2.96	3.27	4.42	5.17	4.25	5.02	2.89	2.77	3.37	49.69
1908	3.20	3.08	7.10	4.77	7.02	2.46	4.38	1.53	0.62	0.38	0.91	3.21	38.66
1909	2.90	4.25	3.35	5.95	2.64	4.60	3.50	3.50	1.77	3.28	1.05	3.05	39.84
1910	8.62	3.61	0.53	3.89	3.18	5.01	4.22	2.49	4.83	2.04	2.61	3.97	45.00
Mean	3.73	3.00	3.88	3.74	3.74	4.28	5.00	3.91	2.72	2.46	2.47	3.33	42.63

Mahoning, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	4.50	1.65	0.66	1.83	1.68	0.58	2.71	5.45	1.36	4.12	2.69	1.61	28.84
1886	3.50	1.73	2.70	4.10	1.53	3.71	4.24	1.11	4.14	1.33	4.68	2.51	35.28
1887	1.80	4.86	1.00	1.13	2.19	-----	0.92	3.78	3.17	-----	2.63	0.88	-----
1888	2.74	0.82	2.31	2.72	3.39	3.16	4.79	3.34	3.06	4.99	3.89	1.86	37.07
1889	3.26	1.25	1.45	4.53	2.95	4.09	3.00	1.18	1.88	1.90	2.67	3.56	31.72
1890	4.03	3.08	3.72	2.83	5.63	1.76	0.59	3.58	4.52	5.54	1.59	1.60	38.47
1891	2.82	7.20	3.10	2.86	1.81	5.23	3.81	2.89	1.01	1.61	4.01	3.65	40.00
1892	1.69	3.33	3.72	1.92	6.67	3.87	2.87	1.89	3.53	0.75	2.95	1.40	34.59
1893	2.88	9.28	2.30	5.71	4.33	4.52	4.89	4.48	2.77	3.40	2.36	4.46	51.38
1894	3.03	3.06	2.55	3.94	4.81	3.02	1.60	4.30	7.91	2.19	2.03	4.53	42.97
1895	4.65	0.59	1.51	3.40	2.28	3.46	3.44	3.24	0.69	0.56	2.97	-----	-----
Mean	3.17	3.35	2.27	3.18	3.39	3.34	2.89	3.20	3.09	2.64	2.95	2.61	37.80

Station discontinued December, 1895.

Mannington, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1901	-----	0.75	2.81	8.55	5.74	3.11	4.35	3.93	3.38	0.20	5.35	3.69	-----
1902	2.71	1.80	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1903	-----	-----	3.40	3.61	3.26	6.62	4.81	1.73	-----	2.20	2.63	1.68	-----
1904	1.95	1.83	5.14	3.29	3.29	4.60	2.57	4.36	2.38	1.48	0.33	2.54	33.76
1905	3.61	1.50	4.83	3.01	3.97	3.08	-----	-----	2.71	5.35	-----	-----	-----
1906	-----	-----	-----	4.52	2.66	4.49	4.76	4.82	2.27	2.72	1.99	5.07	-----
1907	8.33	2.70	5.89	3.14	4.99	4.95	6.78	3.58	3.87	2.57	3.04	3.67	53.51
1908	2.31	3.55	5.86	3.53	5.62	2.03	4.56	2.86	1.42	1.29	0.80	3.25	37.08
1909	3.76	5.04	3.90	5.34	3.67	5.18	3.12	3.00	1.44	2.19	0.71	2.93	40.28
1910	7.02	2.75	0.16	2.32	4.64	3.11	4.02	2.07	4.98	1.51	2.53	2.59	37.70
Mean	4.24	2.49	4.00	4.15	4.20	4.13	4.37	3.29	2.81	2.17	2.17	3.18	40.47

Morgantown, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1873	3.34	5.31	4.01	2.18	4.11	5.68	7.61	4.71	3.52	5.76	3.54	2.09	52.76
1874	3.17	2.27	3.45	7.20	1.25	4.55	5.75	2.16	5.05	0.14	4.72	5.30	45.11
1875	3.12	2.74	5.41	2.90	1.69	4.09	7.89	5.58	5.10	3.57	4.18	3.99	50.26
1876	4.25	3.85	4.97	2.80	3.26	3.00	9.35	3.77	7.16	1.63	2.17	1.95	48.16
1877	4.26	1.09	3.98	2.51	2.25	6.70	5.80	4.65	2.54	3.53	4.52	1.62	43.45
1878	3.95	1.20	3.82	2.80	2.87	4.35	3.74	2.50	3.24	3.87	5.95	4.84	43.13
1879	3.41	2.38	4.56	1.47	1.35	4.64	7.10	6.62	1.27	1.62	2.24	6.70	43.36
1880	5.77	4.53	5.10	4.30	2.24	6.66	3.80	7.25	3.18	3.07	1.99	3.99	51.88
1881	3.08	3.56	2.12	2.30	3.28	4.77	5.61	0.41	2.78	4.55	3.19	5.93	41.58

Morgantown, W. Va.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1882	6.78	5.41	7.18	3.36	4.51	3.39	3.64	7.72	7.23	1.86	2.28	1.92	55.28
1883	4.93	7.07	4.01	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1885	4.75	2.62	1.60	3.31	-----	6.18	2.78	7.43	1.45	5.07	2.75	2.39	-----
1886	4.01	2.26	3.15	4.50	6.46	7.00	4.29	5.55	3.51	1.51	4.02	-----	-----
1887	1.33	6.28	1.32	3.35	1.16	3.08	2.96	4.32	3.19	0.81	1.37	1.55	30.72
1888	6.85	2.34	3.77	2.39	5.82	3.73	7.29	8.70	5.03	7.14	4.90	1.92	59.88
1889	2.75	2.68	3.09	4.97	6.37	4.47	5.12	1.61	3.91	3.34	7.87	2.85	49.03
1890	5.83	5.87	5.84	4.13	8.10	6.83	3.41	7.08	7.71	8.20	2.67	3.87	69.54
1891	3.93	6.31	4.15	2.72	3.20	6.08	7.52	7.45	3.20	2.59	3.68	3.82	54.65
1892	3.64	2.05	4.68	3.02	5.28	3.15	6.97	1.81	1.42	1.30	2.89	2.38	38.59
1893	2.97	5.05	1.02	5.46	3.38	1.94	1.66	1.34	2.20	2.89	2.38	2.14	32.43
1894	2.45	3.56	1.57	2.95	1.03	1.70	3.07	1.77	2.52	3.14	3.47	3.83	31.06
1895	4.74	1.45	1.77	2.48	1.39	5.55	2.82	2.18	1.25	1.02	1.65	1.85	28.15
1896	0.96	3.74	3.35	1.68	3.57	4.16	9.80	1.91	3.78	3.08	4.17	1.36	41.56
1897	2.35	3.94	3.88	3.80	4.91	5.77	5.55	3.04	1.23	0.29	5.24	2.77	42.77
1898	5.78	1.68	6.20	4.86	4.78	5.17	4.01	7.91	2.79	5.56	2.67	0.71	52.12
1899	4.37	5.67	6.63	1.94	4.72	6.43	3.38	1.78	2.26	0.50	1.35	3.50	42.53
1900	1.59	2.96	3.59	1.51	2.14	5.39	6.93	4.33	0.48	3.91	5.06	1.54	39.43
1901	1.96	0.55	3.67	6.15	6.10	2.34	1.86	7.37	3.68	0.36	3.02	5.57	42.63
1902	3.63	2.48	3.92	3.48	1.72	7.16	8.42	4.87	3.24	3.95	2.24	6.12	51.23
1903	2.87	6.47	4.28	3.55	4.12	5.21	5.46	1.34	1.21	3.21	2.26	1.70	41.68
1904	2.70	2.02	4.32	2.86	2.91	5.55	4.50	2.18	1.38	1.74	0.15	2.56	32.87
1905	3.48	1.75	5.13	3.38	3.63	3.94	5.36	4.16	1.96	4.98	2.48	3.85	44.10
1906	3.92	1.58	3.73	4.10	3.14	4.52	3.57	2.93	2.85	3.14	1.62	5.48	40.58
1907	7.51	2.24	6.97	2.79	4.06	4.33	9.36	2.62	4.97	3.44	3.05	3.04	54.38
1908	2.23	3.19	6.04	3.28	6.04	2.74	3.55	1.29	0.70	0.53	0.82	2.26	32.67
1909	4.07	3.85	2.48	5.20	2.80	5.18	3.11	2.52	1.32	2.55	0.83	2.00	35.91
1910	6.70	2.63	0.36	2.06	3.69	4.89	4.08	2.32	3.34	1.77	2.24	2.13	36.21
Mean	3.88	3.37	3.92	3.38	3.62	4.73	5.19	4.03	3.20	2.93	3.04	3.13	43.04

No records for 1884.

Mt. Morris, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	-----	-----	-----	-----	2.99	4.26	2.59	3.92	0.45	2.92	1.54	-----	-----
1886	-----	-----	-----	2.95	3.00	1.95	2.25	3.12	2.40	2.85	3.30	-----	-----
1887	-----	-----	-----	-----	2.46	2.35	2.37	3.04	1.36	1.26	-----	-----	-----
1888	-----	-----	-----	2.80	2.40	1.95	2.25	3.25	2.85	3.00	-----	-----	-----
1889	-----	-----	1.40	2.15	2.93	7.30	3.09	2.80	-----	-----	-----	-----	-----
1890	-----	-----	1.64	3.39	5.20	4.74	1.43	2.49	6.43	3.46	2.07	-----	-----
1891	2.00	3.40	1.90	1.41	1.01	2.04	2.95	3.66	0.74	1.83	2.23	2.92	26.09
1892	-----	-----	-----	0.64	4.90	4.77	2.05	5.34	1.18	1.33	-----	-----	-----
1893	-----	-----	-----	3.08	5.62	0.87	1.97	5.20	2.95	1.88	1.10	2.09	-----
1894	2.58	2.78	1.97	4.13	6.27	2.08	1.51	2.27	4.28	2.57	0.54	-----	-----
1895	-----	-----	-----	1.62	1.48	2.67	1.74	3.41	1.84	0.84	2.60	2.50	-----
1896	2.60	5.35	1.92	0.46	1.66	2.82	4.91	1.85	3.94	1.41	2.60	1.50	31.02
1897	1.40	1.00	2.70	2.10	2.55	2.10	2.20	0.20	1.00	0.60	2.20	1.80	19.85
1898	2.85	1.40	0.15	1.80	2.63	2.40	2.10	4.56	1.55	3.00	1.74	1.60	25.78
1899	1.20	0.65	1.40	1.50	3.05	0.02	3.07	0.05	1.74	0.24	1.20	3.22	17.34
1900	1.68	1.00	3.20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	2.04	2.23	1.81	2.16	3.21	2.82	2.43	3.01	2.34	1.94	1.92	2.23	28.14

No records after 1900.

New Martinsville, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	-----	-----	-----	-----	-----	-----	4.40	2.04	2.60	0.61	-----	2.93	-----
1893	2.94	6.30	0.89	5.06	6.15	4.11	2.59	3.49	1.67	5.12	1.80	2.57	42.69
1894	2.48	3.26	2.77	3.51	3.40	2.41	1.74	1.88	1.25	2.40	1.98	3.60	30.68

New Martinsville, W. Va.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1895	4.76	0.70	2.39	2.84	1.84	2.27	4.14	3.32	1.98	1.72	2.70	3.93	32.59
1896	1.91	2.78	3.90	2.07	3.06	6.81	15.09	2.26	4.28	2.18	3.32	2.20	49.86
1897	1.48	5.91	3.32	3.79	3.21	4.16	7.33	1.89	0.55	0.18	6.69	4.39	42.90
1898	5.70	1.88	3.67	3.53	4.54	2.34	6.33	7.56	2.04	5.27	3.22	2.79	48.87
1899	3.88	2.81	5.70	1.75	3.17	3.57	4.29	1.40	6.35	1.56	2.55	3.41	40.44
1900	3.29	4.26	3.36	1.42	3.47	3.38	3.84	3.30	0.34	1.45	5.38	1.82	35.31
1901	2.07	0.47	3.44	6.31	5.07	3.87	4.96	2.49	2.72	0.39	2.76	4.28	38.83
1902	2.65	1.62	3.71	4.12	1.34	5.59	4.91	2.64	2.88	2.70	3.08	5.32	40.56
1903	3.00	6.38	4.85	3.95	2.95	4.02	3.44	1.26	1.05	2.05	2.30	2.37	37.62
1904	1.95	1.93	5.14	2.67	1.97	4.47	3.45	1.54	1.92	2.01	0.12	3.09	30.26
1905	2.42	1.94	4.77	3.76	4.47	2.94	3.20	3.69	2.69	4.70	3.29	3.92	41.79
1906	3.31	1.52	4.43	3.46	2.95	5.11	3.77	3.61	2.58	2.79	1.78	5.42	40.73
1907	6.69	1.92	8.50	3.78	5.26	4.92	6.91	2.70	5.71	2.98	2.71	3.50	55.58
1908	2.35	3.45	5.89	5.17	6.39	1.55	6.79	0.92	1.69	2.31	0.99	3.03	40.53
1909	3.73	6.17	3.40	a5.61	4.30	4.88	4.05	3.83	2.32	2.09	0.85	2.40	43.63
1910	5.98	3.95	0.12	3.11	3.79	1.55	4.75	1.09	2.22	2.09	1.44	2.92	33.01
Mean	3.33	3.15	3.90	3.66	3.74	3.77	5.05	2.68	2.47	2.35	2.61	3.36	40.33

a. Estimated from surrounding stations.

New Waterford, Ohio.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1855	1.90	1.00	2.10	1.10	3.00	-----	-----	-----	-----	-----	-----	-----	-----
1858	0.55	3.30	1.08	4.12	7.44	4.76	4.12	3.84	1.30	3.01	3.48	5.45	42.45
1859	1.49	4.02	3.30	4.56	1.37	3.11	2.85	3.38	4.62	3.13	3.96	4.39	40.18
1861	2.17	1.44	1.69	2.71	3.00	2.75	2.02	9.59	2.68	1.84	4.05	1.34	35.28
1862	4.71	2.57	3.04	2.70	2.16	3.35	1.38	0.18	1.07	1.22	2.92	3.46	28.76
1863	-----	2.41	3.18	0.88	1.41	2.98	2.15	1.89	2.44	2.98	1.04	3.83	-----
1864	1.72	1.34	2.96	2.21	2.24	0.93	1.87	4.74	5.97	2.18	1.63	2.32	30.11
1865	3.50	2.03	5.44	3.72	2.26	6.27	3.70	2.79	6.75	1.15	1.04	2.72	41.37
1866	1.33	1.88	4.75	2.78	1.46	11.19	4.10	3.42	7.68	2.22	2.56	3.62	46.99
1867	3.59	2.70	4.91	3.99	4.88	3.45	3.13	3.53	0.21	2.74	1.15	2.90	37.18
1868	2.69	1.55	3.14	2.84	4.53	1.85	4.80	2.88	2.38	1.24	2.58	2.21	32.69
1869	3.44	1.89	4.12	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1870	-----	3.10	4.09	-----	-----	-----	-----	-----	-----	-----	-----	2.73	-----
1871	-----	-----	2.39	1.53	2.08	4.77	6.43	-----	-----	-----	-----	-----	-----
1894	-----	-----	-----	-----	-----	-----	-----	0.58	4.27	2.20	1.98	3.49	-----
1895	6.90	0.54	0.90	1.76	1.44	2.39	3.36	5.00	1.52	1.42	3.50	5.50	34.23
1896	1.74	3.07	3.13	4.52	1.98	8.09	8.11	3.24	4.46	1.39	1.54	2.46	43.73
1897	1.88	4.81	4.02	3.40	2.60	4.10	8.88	2.09	1.59	0.21	5.72	4.49	43.79
1898	6.43	3.30	6.10	1.83	4.18	5.57	3.70	6.50	1.95	3.82	4.34	3.48	51.20
1899	2.68	2.67	4.15	1.61	5.69	3.20	3.44	2.08	4.09	1.85	1.96	3.36	36.78
1900	2.24	3.75	2.84	1.42	2.94	3.58	7.69	3.83	1.52	2.11	5.71	2.13	39.76
1901	2.12	1.20	3.99	6.96	4.58	4.21	2.65	7.21	3.85	0.29	3.51	3.24	43.81
1902	3.05	1.85	3.22	2.26	3.15	6.05	5.53	2.30	2.09	2.74	1.84	6.11	40.18
1903	2.61	5.42	5.34	2.87	2.20	6.51	4.07	5.72	0.32	3.43	2.25	2.41	43.15
1904	4.40	3.98	4.39	5.72	3.71	5.23	3.70	3.53	0.72	0.95	0.68	3.21	40.22
1905	1.25	0.69	3.25	2.68	3.79	6.31	4.21	3.30	3.20	3.11	2.29	2.38	36.46
1906	1.84	1.23	3.86	2.42	2.16	3.36	4.17	5.44	2.89	3.06	2.42	3.73	36.58
1907	5.63	1.66	6.90	4.08	3.50	3.92	3.12	1.77	3.77	1.91	1.71	2.85	40.82
1908	2.07	3.00	5.78	3.08	5.24	2.91	2.25	2.73	0.04	2.51	1.52	3.17	34.30
1909	4.58	4.70	3.59	4.96	2.58	5.34	2.86	0.76	0.65	1.73	1.69	1.93	35.37
1910	5.86	3.50	0.20	2.68	3.26	2.12	1.83	2.26	4.03	2.58	2.88	1.35	32.55
Mean	3.05	2.57	3.59	3.05	3.17	4.12	3.93	3.28	2.82	2.08	2.59	3.32	38.72

No records for June, 1855 to December, 1857; for 1860; or for August, 1871 to July, 1894.
Values for 1855 to 1871 are for New Lisbon, about 9 miles southwest of New Waterford.

Nunda, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1898	3.85	1.55	-----	3.85	5.45	6.78	1.89	7.29	2.05	4.00	3.63	2.33	-----
1899	1.61	1.98	2.86	2.35	4.37	1.22	2.05	2.03	2.83	2.09	-----	-----	-----
1900	3.17	5.63	4.27	2.21	3.48	0.75	-----	-----	1.87	3.78	-----	-----	-----
1901	2.56	6.97	5.67	-----	-----	-----	-----	-----	-----	-----	2.30	5.18	-----
1902	2.93	1.60	1.35	2.22	2.29	5.16	9.93	1.25	3.05	3.86	1.60	2.51	37.75
1903	1.04	2.10	4.17	3.63	0.56	4.01	3.14	-----	2.04	2.34	-----	-----	-----

No records after 1903.

Oakland, Md.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1903	-----	-----	-----	-----	-----	-----	-----	-----	2.28	2.96	2.15	-----	-----
1904	2.07	2.31	2.32	2.27	4.00	3.13	4.78	1.52	2.96	1.53	0.82	4.00	31.71
1905	2.97	3.72	1.42	2.22	4.28	4.87	7.61	4.47	2.43	4.91	3.40	2.59	44.89
1906	a4.00	0.80	5.18	4.17	1.97	5.95	4.29	2.98	3.74	2.33	1.50	7.16	44.07
1907	6.55	2.23	3.85	3.21	5.19	5.20	7.91	3.99	3.80	2.59	4.32	3.84	52.68
1908	3.11	4.61	6.48	3.89	11.60	2.72	4.95	3.51	0.48	0.70	1.00	3.65	46.70
1909	2.92	4.58	3.74	6.16	3.74	7.01	3.06	4.97	3.56	4.41	1.34	2.78	48.27
1910	5.35	2.78	0.95	3.11	3.43	6.34	3.19	2.36	3.65	1.75	2.94	2.35	38.20
Mean	3.85	3.00	3.42	3.58	4.90	5.03	5.11	3.40	2.86	2.65	2.18	3.77	43.79

a. Estimated from surrounding stations.

Oil City, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	2.55	1.20	5.09	1.03	0.64	6.51	3.43	1.81	2.99	3.20	5.90	2.22	36.57
1878	4.58	2.97	3.17	2.87	4.40	4.44	5.53	2.65	6.34	2.45	4.67	4.78	48.85
1879	4.42	4.58	3.94	2.88	1.97	2.93	3.88	1.90	2.97	3.61	6.22	5.82	45.12
1880	4.55	2.80	2.25	4.55	2.82	4.62	1.73	2.68	2.68	3.40	2.50	2.30	36.88
1881	4.78	4.33	2.80	2.29	3.53	9.10	1.43	0.72	2.33	4.84	4.84	5.60	46.59
1882	3.61	4.53	3.72	2.53	6.09	5.23	3.27	4.97	6.07	2.17	2.41	4.10	48.70
1887	1.40	7.04	1.27	2.15	2.22	-----	5.53	4.61	2.24	3.77	2.56	1.76	-----
1888	4.57	0.79	2.30	3.24	1.30	2.58	1.24	0.71	1.29	0.54	2.98	1.26	22.80
1889	1.81	0.29	1.50	3.98	3.85	7.04	4.30	1.65	3.43	3.17	2.12	1.63	34.77
1890	1.60	2.46	2.75	1.31	8.50	4.91	2.24	5.56	7.31	3.97	2.58	1.96	45.15
1891	2.16	5.24	3.23	1.91	1.08	5.13	8.63	2.59	1.50	1.70	2.85	2.18	38.20
1892	1.32	2.07	1.32	0.78	7.56	4.07	4.83	3.45	2.74	1.14	2.84	0.95	32.07
1893	3.29	8.11	2.92	4.92	6.15	3.99	4.52	3.04	2.39	4.02	1.99	4.63	49.97
1894	3.48	2.94	1.90	3.17	5.04	1.62	1.95	0.41	6.51	2.43	2.22	2.65	34.32
1895	4.63	1.49	1.64	2.68	4.22	2.58	3.65	3.09	5.15	1.24	5.11	5.32	40.80
1896	1.66	3.56	3.18	2.96	2.73	6.88	6.69	2.16	4.40	2.15	2.50	2.10	40.97
1897	2.59	2.91	5.36	3.54	4.12	4.05	7.97	5.07	1.53	0.37	6.37	3.63	47.51
1898	5.32	2.53	5.74	2.13	4.64	4.56	4.45	6.73	2.11	5.18	4.33	2.90	50.62
1899	2.57	2.61	4.63	1.58	5.14	3.18	5.39	1.28	4.47	1.72	2.31	4.85	39.73
1900	2.77	3.58	3.89	1.40	1.77	3.84	6.39	2.65	2.96	1.73	5.22	1.63	37.83
1901	2.55	1.76	4.34	5.99	5.14	5.37	3.42	4.11	6.61	0.39	3.96	4.31	47.95
1902	1.88	1.63	3.12	2.90	3.65	7.24	10.66	2.02	3.06	2.74	1.78	4.80	45.54
1903	3.82	5.07	5.06	3.44	2.62	7.08	7.04	4.32	2.04	2.92	2.67	2.82	48.90
1904	5.45	3.51	6.10	4.50	4.39	2.30	3.42	4.02	2.66	1.64	0.92	2.80	41.71
1905	3.46	2.64	3.49	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	3.36	3.34	3.44	2.87	3.90	4.75	4.61	3.01	3.57	2.52	3.41	3.21	41.99

No records 1883-1886.

Olean, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1909	3.18	5.07	3.20	6.21	3.43	3.97	2.72	3.03	3.50	3.00	1.64	1.64	40.59
1910	5.70	4.29	0.72	4.97	3.70	2.08	3.34	2.62	5.26	3.27	3.86	2.59	42.40

Orangeville, Ohio.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	3.20	1.30	2.60	2.60	2.70	3.35	1.80	1.80	3.80	2.30	1.95	2.85	30.25
1890	4.30	4.20	2.60	3.15	7.70	2.85	1.80	3.90	5.05	5.50	2.55	2.75	46.35
1891	2.05	5.15	3.35	1.50	1.95	3.00	2.55	1.15	2.05	1.20	3.45	2.50	29.90
1892	2.55	2.80	3.10	1.55	6.95	5.90	2.35	2.70	2.90	0.95	2.30	1.05	35.10
1893	2.90	5.55	3.10	4.45	7.00	2.20	2.20	2.80	-----	-----	1.50	3.15	-----
1894	2.20	1.60	2.05	3.05	2.05	0.45	2.40	0.77	5.70	1.35	1.55	1.80	24.97
1895	3.75	0.40	0.60	0.95	1.80	3.55	1.90	3.35	3.00	1.03	3.25	4.15	27.73
1896	1.35	3.00	2.35	2.35	2.10	5.52	3.60	1.75	3.60	0.63	1.75	1.95	29.95
1897	1.84	2.10	3.80	2.08	4.00	3.17	8.07	3.88	1.17	0.18	5.61	2.46	38.36
1898	4.06	2.25	4.49	1.68	3.09	2.55	2.53	5.01	3.10	3.85	3.15	2.20	37.96
1899	2.05	1.35	3.30	0.92	4.16	3.25	1.55	2.60	2.47	1.55	0.75	2.90	26.85
1900	2.22	2.30	2.29	0.45	2.95	1.50	3.93	1.15	1.10	1.40	3.27	1.20	23.76
1901	1.21	1.20	3.10	3.50	4.07	2.32	2.75	2.03	4.85	0.30	2.88	3.50	31.71
1902	1.55	0.90	2.02	3.05	3.42	4.48	6.28	0.46	2.17	0.97	1.40	3.55	30.25
1903	1.93	3.22	4.67	4.28	1.31	5.72	6.87	6.34	1.89	2.82	2.88	2.92	44.85
1904	4.34	4.33	2.96	3.75	4.15	2.83.	5.36	4.07	1.95	1.23	1.10	1.45	37.52
1905	1.62	0.50	2.43	2.16	3.52	5.11	6.99	4.70	3.49	3.68	2.03	1.70	37.93
1906	1.55	0.85	3.20	2.05	2.10	2.01	2.56	3.25	2.54	3.27	1.59	2.15	27.12
1907	2.46	0.75	2.88	-----	-----	-----	-----	-----	-----	-----	2.00	2.36	-----
1908	2.58	4.65	2.77	4.34	3.33	2.32	8.01	2.11	2.14	1.23	1.58	3.65	38.71
1909	4.84	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	2.60	2.42	2.88	2.52	3.60	3.27	3.87	2.83	2.94	1.86	2.33	2.51	33.07

Station discontinued February 1, 1909.

Otto, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.74	2.24	-----
1903	2.06	1.67	3.33	3.23	2.78	5.16	4.22	4.79	1.20	4.29	2.08	1.43	36.24
1904	3.62	2.39	3.17	3.05	3.88	3.47	5.94	1.63	3.26	3.22	0.63	1.46	35.70
1905	2.11	0.80	1.76	-----	2.75	5.58	3.67	2.34	2.95	4.24	0.96	1.05	-----
1906	0.43	0.54	2.34	1.97	2.44	1.96	-----	2.44	2.90	5.09	2.43	3.06	-----
1907	2.39	0.58	0.38	-----	0.79	5.51	3.48	1.73	-----	-----	1.11	1.13	-----
1908	2.89	-----	2.97	2.11	5.55	2.41	3.95	-----	1.97	0.97	0.80	1.37	-----
1909	1.69	4.13	3.43	2.47	3.61	4.37	-----	-----	2.58	2.92	2.74	0.81	-----
1910	2.45	3.47	0.89	3.17	3.44	1.00	-----	-----	-----	-----	-----	-----	-----
Mean	2.20	1.94	2.78	2.67	3.15	3.68	4.25	2.58	2.48	3.45	1.56	1.57	-----

Parkers Landing, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	6.49	1.22	0.70	3.00	4.56	4.20	7.40	9.26	2.78	4.47	2.11	1.90	48.09
1886	2.60	1.68	2.14	4.12	1.34	3.68	2.86	2.01	4.06	0.68	4.43	2.92	32.52
1887	1.50	7.43	2.08	2.71	2.42	3.04	3.80	3.41	2.13	0.94	2.61	1.18	33.25
1888	5.20	1.76	2.09	2.19	5.45	-----	-----	-----	-----	3.22	3.53	1.76	-----
1889	3.07	1.88	2.03	2.92	1.78	4.42	5.24	3.06	3.79	3.28	4.00	4.06	39.53
1890	4.96	5.33	4.24	4.55	8.44	2.08	1.96	5.92	6.68	7.04	2.18	3.91	57.29
1891	2.49	6.04	3.73	2.29	1.62	7.07	7.38	3.16	2.20	1.64	3.15	3.87	44.64
1892	3.47	2.41	3.73	2.78	9.06	5.35	2.41	2.73	3.87	0.85	3.33	1.63	41.62
1893	2.70	7.80	3.18	5.40	5.28	6.41	2.68	4.58	2.53	4.38	2.47	4.09	51.50
1894	3.16	2.72	2.09	4.35	4.75	3.63	3.30	1.10	9.82	2.74	2.64	3.54	43.84
1895	4.16	0.84	2.20	2.95	2.33	3.76	4.54	2.97	2.77	0.75	4.00	4.30	35.57
1896	1.62	3.26	3.46	2.04	3.10	4.11	6.99	5.01	4.24	2.21	2.52	1.68	40.24
1897	2.24	3.64	4.95	3.42	3.41	3.69	7.23	3.82	1.39	0.77	5.39	3.38	43.33
1898	5.50	2.52	7.17	1.99	3.92	5.89	2.13	6.36	1.23	5.05	3.18	1.99	46.93
1899	2.03	1.73	3.92	1.54	4.49	5.58	6.18	0.86	4.18	1.64	3.20	4.06	39.41
1900	2.67	3.88	4.35	1.51	3.52	4.57	5.17	3.30	1.63	2.24	4.20	1.37	38.41
1901	2.75	1.02	4.66	7.57	5.25	4.57	2.39	7.88	4.32	0.75	4.53	4.86	50.55
1902	2.26	1.50	3.22	3.30	2.87	6.14	7.08	2.24	1.82	3.54	1.35	5.56	40.88
1903	3.38	5.16	5.52	3.40	3.02	6.28	5.22	4.80	2.62	2.48	3.94	1.80	47.62

Parkers Landing, Pa.—(Continued.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1904	3.84	3.10	6.08	6.42	3.40	4.02	3.72	3.96	1.24	2.18	0.78	3.12	41.86
1905	2.92	1.54	2.94	2.48	3.80	5.02	7.42	5.10	4.22	4.02	2.56	3.84	45.86
1906	2.72	0.64	3.00	2.22	3.22	5.04	2.94	6.90	4.26	3.64	2.12	3.48	40.18
1907	4.40	1.54	5.76	3.38	2.95	7.24	4.78	1.28	3.40	2.62	2.33	2.62	42.30
1908	2.86	5.16	5.88	4.50	5.52	2.70	4.90	2.88	0.82	1.06	1.06	3.74	41.08
1909	4.18	5.52	4.62	7.28	3.00	5.64	2.96	1.82	1.94	2.56	1.60	2.84	43.96
1910	6.08	6.64	0.24	3.10	3.14	1.80	2.94	2.16	6.08	2.04	3.18	3.56	40.96
Mean	3.43	3.31	3.61	3.51	3.91	4.64	4.54	3.86	3.36	2.57	2.94	3.12	42.86

Parsons, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1899	4.25	4.24	5.70	3.00	6.93	3.47	4.63	2.37	3.95	1.10	1.75	1.22	42.61
1900	1.90	3.75	3.00	2.05	1.70	5.90	3.70	3.10	0.50	2.50	4.00	3.00	35.10
1901	2.60	1.10	0.90	2.50	2.50	3.37	3.50	5.10	1.90	0.75	1.75	7.50	33.47
1902	2.80	1.62	5.60	4.00	2.90	3.00	3.30	1.30	3.43	0.90	2.60	6.25	37.70
1903	2.80	6.30	4.00	3.90	2.56	10.70	3.75	3.25	2.46	3.04	2.17	2.05	46.98
1904	3.65	3.52	4.60	3.44	4.46	3.84	1.83	1.23	2.77	2.91	0.66	4.40	37.31
1905	4.12	3.10	4.87	2.63	4.70	4.27	5.66	3.33	2.47	5.78	2.96	1.57	45.46
1906	4.40	2.55	6.16	5.41	2.09	4.02	3.32	7.50	4.41	3.43	2.00	5.26	50.55
1907	8.33	4.16	6.20	4.14	4.75	5.42	11.82	2.00	3.00	3.79	4.50	4.80	62.91
1908	5.76	5.47	4.75	5.55	9.33	3.53	2.60	2.69	0.81	0.40	0.99	2.61	44.49
1909	5.22	3.37	4.64	5.98	1.80	7.13	5.88	5.10	7.22	4.35	0.70	4.19	55.58
1910	9.01	2.20	0.98	2.97	4.87	11.27	3.89	0.92	2.18	1.50	2.35	5.15	47.29
Mean	4.57	3.45	4.28	3.79	4.05	5.50	4.49	3.16	2.93	2.54	2.20	3.57	44.93

Philippi, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	-----	-----	3.35	5.22	5.43	2.59	3.54	3.40	3.05	1.45	3.65	2.90	-----
1893	4.99	4.58	1.08	4.78	3.41	2.65	3.15	2.56	1.70	3.71	2.16	1.72	36.49
1894	1.90	3.08	1.75	4.16	4.62	3.04	2.48	1.35	1.45	2.65	2.10	5.35	33.93
1895	3.36	1.40	3.90	3.77	2.26	2.62	5.15	2.87	1.33	0.95	2.50	2.40	32.51
1896	2.00	3.00	5.53	3.00	3.63	4.71	15.70	2.70	8.26	2.20	4.33	2.39	57.45
1897	2.09	7.29	3.99	7.10	5.66	7.89	5.80	5.75	4.00	1.50	5.50	5.50	62.07
1898	6.00	2.50	7.67	4.31	5.84	3.50	3.91	11.57	2.79	5.19	3.80	2.49	59.57
1899	5.29	4.87	5.37	1.49	6.68	4.42	7.92	1.90	4.28	1.01	2.67	3.83	49.73
1900	1.82	4.18	4.56	1.15	2.71	4.98	4.28	2.18	1.08	4.67	5.62	3.23	40.46
1901	3.55	0.82	3.26	7.03	5.58	4.58	1.76	3.33	2.70	0.51	3.07	6.00	42.19
1902	1.95	1.00	4.75	3.50	4.00	7.06	4.40	2.71	3.03	2.35	3.01	7.34	45.10
1903	4.72	5.86	5.36	4.24	3.92	5.03	3.74	2.40	2.29	3.00	3.41	2.49	46.46
1904	3.11	2.12	4.03	2.37	2.47	5.71	3.61	2.79	2.82	1.74	0.46	4.29	35.52
1905	3.02	2.48	4.98	3.54	6.31	6.12	8.56	3.91	2.14	5.31	3.07	3.31	52.75
1906	4.17	1.88	5.09	6.16	2.45	5.53	4.21	4.20	3.58	3.47	2.49	6.27	49.50
1907	9.08	3.07	5.61	3.24	4.76	4.76	7.39	5.13	4.56	3.67	3.12	3.56	57.95
1908	3.43	4.99	6.92	3.78	7.47	2.97	5.72	2.56	1.25	0.55	1.00	3.49	44.13
1909	3.53	4.72	4.22	5.73	2.46	8.45	3.89	4.44	3.83	4.21	1.13	2.71	49.32
1910	7.02	4.21	0.67	2.34	3.32	4.45	5.12	2.14	4.27	1.68	2.98	2.24	40.44
Mean	3.94	3.44	4.32	4.05	4.36	4.79	5.27	3.57	3.08	2.62	2.95	3.76	46.42

Pickens, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	5.87	0.94	4.96	2.99	3.64	6.12	4.76	2.51	4.05	3.76	6.29	2.47	48.36
1878	5.27	2.00	4.38	4.01	5.69	4.84	7.31	4.89	2.84	4.65	7.98	5.14	59.00
1879	3.13	3.15	5.48	1.09	3.70	4.57	6.13	3.64	2.63	1.64	3.07	6.44	44.67
1880	4.30	5.51	6.57	5.77	3.47	6.45	5.57	5.54	3.35	3.88	0.59	4.51	55.51
1881	3.80	4.51	3.75	4.15	4.58	6.99	9.48	1.45	1.37	4.51	3.23	8.81	56.63
1882	9.50	6.95	6.65	4.26	7.15	8.27	7.65	12.60	7.04	1.30	2.76	3.27	77.40
1883	5.26	8.18	5.37	6.72	4.38	6.55	7.84	1.73	3.09	5.21	2.05	5.15	61.53
1884	6.00	5.24	4.96	2.70	5.51	5.69	5.12	4.30	0.92	2.45	2.66	4.30	48.85
1885	5.90	2.65	2.54	5.04	3.50	4.66	4.41	3.14	1.43	5.80	4.06	3.19	46.32
1886	3.45	2.71	4.46	3.44	7.08	5.46	4.82	3.77	4.37	1.35	4.53	4.57	50.01
1887	3.75	7.68	3.02	4.91	3.65	8.14	2.86	3.96	3.49	1.20	1.24	2.18	46.08
1888	4.32	2.79	4.38	2.61	5.85	2.81	6.28	4.67	2.77	8.14	2.97	3.05	50.64
1902	-----	-----	-----	6.13	6.09	6.38	7.28	1.71	3.44	2.82	4.03	9.95	-----
1903	6.45	9.58	6.11	6.19	5.70	7.39	3.60	5.85	2.78	2.71	4.98	3.30	64.64
1904	5.82	4.55	6.10	5.52	4.84	5.00	4.70	4.16	2.83	2.00	2.20	5.91	53.63
1905	4.98	3.66	4.75	5.57	6.24	4.76	6.48	4.10	1.91	2.46	2.23	3.38	50.52
1906	3.53	1.57	6.96	5.39	5.48	7.31	4.52	10.72	5.44	5.41	4.34	9.61	70.28
1907	11.54	4.83	7.10	6.66	3.84	8.69	13.36	6.83	3.43	4.71	5.42	4.45	80.86
1908	8.19	4.80	6.01	6.88	8.82	4.94	7.53	5.03	1.22	1.28	1.16	4.80	60.66
1909	6.27	6.48	6.19	8.57	3.34	7.71	6.01	5.79	6.77	5.09	3.85	4.00	70.07
1910	10.10	6.56	1.52	4.65	5.26	10.60	6.74	3.67	5.46	2.96	4.41	6.93	68.86
Mean	5.87	4.72	5.06	4.92	5.14	6.35	6.31	4.76	3.36	3.45	3.53	5.02	55.45

Records incomplete, 1889-1901.

Pittsburgh, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1840	1.33	1.33	3.47	2.18	2.93	3.70	1.57	3.89	2.12	2.68	1.71	1.73	28.64
1841	2.74	0.07	4.77	3.82	2.40	4.97	1.73	4.01	1.85	2.31	2.77	3.41	34.85
1842	2.75	2.88	3.75	4.64	2.86	4.96	4.90	3.91	2.20	2.09	1.72	3.79	40.45
1843	2.70	3.31	3.27	2.33	4.05	3.83	1.87	2.32	6.44	3.46	2.87	2.26	38.71
1844	2.20	0.93	3.04	1.79	4.89	4.02	2.44	4.47	2.57	2.85	1.85	1.50	32.55
1845	2.85	1.50	3.04	2.51	1.18	4.04	3.74	3.06	3.39	3.37	2.02	1.19	31.89
1846	2.92	2.73	2.02	3.76	4.62	4.05	7.15	6.05	1.95	4.78	2.60	5.16	47.79
1847	3.01	2.86	3.47	2.55	3.64	5.32	4.18	3.26	3.92	4.76	4.27	4.98	46.22
1848	1.31	0.50	3.20	2.45	5.51	3.03	3.69	2.27	2.08	2.11	3.11	4.88	34.14
1849	2.43	1.31	3.85	0.83	5.83	2.84	1.26	3.26	1.26	3.86	3.97	4.11	34.81
1850	3.76	3.45	2.74	2.59	3.30	2.62	2.82	1.27	3.62	4.29	2.19	4.76	37.41
1851	0.35	3.01	1.43	2.83	3.57	2.04	4.30	2.66	2.62	1.45	3.67	1.71	29.64
1852	1.80	3.34	2.03	9.27	3.84	2.76	2.55	2.76	3.09	2.24	2.67	5.01	41.36
1853	1.56	3.53	1.11	4.16	3.27	1.32	2.74	6.56	2.34	2.04	2.90	2.10	33.63
1854	2.23	2.33	2.82	4.21	2.24	2.06	1.45	1.13	1.76	2.89	1.88	1.67	26.67
1855	2.15	1.77	3.08	2.60	2.33	7.58	5.57	3.57	4.79	1.54	5.07	3.28	43.33
1856	2.64	1.80	1.73	2.29	2.52	3.99	2.71	1.60	1.95	2.05	1.97	1.34	26.59
1857	1.86	1.56	1.03	2.50	6.34	5.14	2.89	4.65	2.20	3.66	3.52	3.61	38.96
1858	1.15	2.78	0.99	4.29	6.60	4.30	3.60	1.90	1.03	2.40	2.37	4.77	36.18
1859	0.43	2.67	3.83	4.79	2.00	3.02	1.87	5.00	2.74	3.00	1.69	4.77	35.71
1860	1.75	1.25	1.19	6.56	3.69	2.17	3.09	3.82	1.81	4.45	3.96	2.04	35.78
1861	1.96	2.65	1.80	3.48	2.70	1.75	4.69	3.00	5.70	-----	1.81	0.44	-----
1862	3.60	1.20	2.87	2.79	2.49	4.00	2.60	1.20	1.51	3.45	2.10	1.57	29.30
1863	3.91	2.33	2.69	2.17	2.11	3.38	1.42	2.26	2.72	3.43	2.45	2.75	31.62
1864	1.48	1.77	4.82	3.24	4.46	2.10	2.55	8.29	8.25	-----	3.93	2.75	-----
1865	2.75	1.37	4.83	3.20	5.36	5.48	6.26	5.54	7.56	3.21	1.48	3.46	50.50
1866	-----	-----	-----	-----	-----	-----	-----	-----	7.50	4.90	4.46	2.75	-----
1867	2.58	4.11	4.30	2.90	-----	-----	-----	-----	-----	-----	-----	-----	-----
1871	-----	2.64	1.03	2.04	0.98	4.77	3.24	5.65	1.56	2.66	3.30	1.25	-----
1872	1.85	1.03	1.38	1.09	2.66	2.69	7.71	2.79	2.57	4.11	0.83	2.88	31.59
1873	3.16	3.08	3.87	3.04	3.21	2.15	3.44	5.19	1.94	6.21	1.72	3.46	40.47
1874	2.92	3.15	2.94	7.20	2.37	1.84	7.68	1.98	2.56	0.06	3.36	3.30	39.36
1875	2.17	1.57	3.45	2.07	2.79	2.85	5.27	2.19	2.56	2.36	2.96	3.79	34.03
1876	3.59	2.83	5.80	2.04	3.35	1.47	5.86	2.72	7.35	1.14	2.03	0.83	37.01
1877	2.99	1.43	5.31	2.88	1.66	3.54	3.98	2.10	1.90	2.76	4.48	1.69	34.72
1878	2.52	1.14	2.42	2.60	1.76	5.18	5.15	1.29	5.55	2.99	4.20	3.96	38.76
1879	1.54	1.74	2.99	1.63	1.20	4.56	7.78	5.56	1.01	0.65	3.36	5.00	37.02

No records for May, 1867, to January, 1871, inclusive.

Pittsburgh, Pa.—(Continued)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1880	3.02	2.63	2.87	2.41	1.25	3.52	2.15	3.62	3.12	2.80	1.73	2.95	32.07
1881	5.55	3.45	3.35	1.81	2.34	6.95	3.86	0.88	0.76	3.75	2.66	3.94	37.30
1882	4.58	3.14	3.78	1.39	5.80	4.14	1.99	4.50	4.08	1.74	2.07	1.42	38.63
1883	3.22	4.92	2.51	3.69	5.38	4.73	5.52	3.40	2.47	2.43	1.50	3.40	43.17
1884	4.82	4.57	3.71	1.11	3.48	1.71	4.04	2.94	1.17	2.01	1.18	4.07	34.81
1885	4.03	1.90	1.14	2.79	3.26	2.66	2.49	5.64	1.69	4.29	2.57	1.64	34.10
1886	3.21	1.39	2.85	4.02	3.50	5.17	5.55	2.85	2.86	1.06	4.91	1.81	39.18
1887	1.92	6.52	1.49	4.29	5.78	4.50	9.51	2.16	2.03	0.39	1.37	1.99	41.95
1888	6.17	1.74	2.51	1.04	4.13	2.22	4.36	7.26	1.77	3.46	3.57	1.66	39.89
1889	2.50	1.58	2.32	3.62	6.45	4.93	5.48	1.88	2.87	2.06	4.61	3.07	41.37
1890	4.18	5.52	3.86	4.87	5.85	3.37	2.22	4.06	4.24	5.66	1.14	5.64	50.61
1891	2.43	6.09	3.11	1.18	3.23	3.90	7.65	1.60	1.90	1.53	2.61	3.05	38.28
1892	3.29	1.85	2.29	2.93	3.77	4.15	5.88	2.22	2.04	0.51	1.81	1.92	32.66
1893	2.36	4.74	1.17	4.94	4.50	2.87	5.08	2.94	1.86	3.22	1.46	2.70	37.84
1894	2.02	2.98	2.41	3.63	4.63	0.61	1.16	0.43	3.68	1.72	1.80	3.10	28.17
1895	4.16	0.77	1.73	1.83	1.97	2.26	2.11	4.29	1.83	1.11	2.24	3.20	27.50
1896	1.63	2.89	4.13	3.39	3.91	4.79	8.96	4.09	4.17	2.26	2.76	1.37	44.35
1897	1.34	4.30	3.50	3.34	2.70	2.97	4.52	2.08	1.65	0.13	5.11	3.44	35.08
1898	3.40	1.60	5.45	1.60	3.99	3.98	2.56	4.09	1.06	3.85	2.34	1.92	35.76
1899	3.41	2.68	3.37	2.59	3.26	3.72	3.13	2.57	2.66	2.10	2.12	2.24	33.85
1900	1.54	2.86	2.35	1.25	1.34	3.25	3.42	0.84	1.01	2.24	3.64	1.99	25.73
1901	1.98	0.91	3.69	8.11	5.80	4.41	2.84	4.04	1.96	0.38	1.80	4.84	40.76
1902	1.49	1.45	4.15	2.70	2.30	5.79	2.94	1.61	2.21	2.79	1.08	3.71	32.22
1903	2.33	3.99	4.29	2.82	1.67	5.27	5.66	4.71	1.04	2.88	2.60	1.55	38.81
1904	2.51	2.00	5.11	3.02	3.48	5.76	2.72	2.36	2.35	2.09	0.22	2.34	33.76
1905	2.36	1.41	3.03	2.07	2.79	6.64	3.01	3.11	2.41	3.58	1.80	3.02	35.19
1906	1.84	1.09	3.85	1.70	2.08	4.08	4.18	2.96	3.10	2.94	0.95	2.52	31.29
1907	5.58	0.74	5.24	1.99	1.79	3.17	4.95	1.89	3.25	1.64	1.59	3.03	34.86
1908	1.65	2.89	5.22	3.59	3.84	1.14	5.07	2.48	0.71	0.95	0.69	1.94	30.17
1909	3.10	4.47	3.14	5.23	1.51	4.92	1.22	3.33	0.76	2.36	0.84	2.30	33.18
1910	5.33	3.60	0.37	2.21	3.24	1.96	1.26	2.47	5.50	1.69	1.32	2.87	31.82
Mean	2.70	2.50	3.05	3.08	3.38	3.68	3.93	3.25	2.81	2.57	2.18	2.87	36.10

Ridgway, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1891	2.80	5.17	2.70	1.80	1.95	4.75	9.01	3.52	1.31	3.29	3.90	4.51	44.71
1892	2.53	2.44	3.41	1.54	7.83	4.43	3.23	4.53	2.44	1.26	2.85	1.04	37.53
1893	2.31	5.03	2.73	4.58	4.14	2.64	3.49	4.19	1.86	2.30	2.35	3.67	39.29
1894	3.44	2.36	1.53	3.12	8.33	2.19	1.68	1.12	5.73	2.38	1.65	3.23	36.76
1895	3.84	1.06	1.52	3.35	2.51	3.63	2.57	2.52	2.20	0.77	2.95	3.00	29.92
1896	1.76	2.75	3.21	2.56	2.66	5.57	7.49	2.45	5.44	2.91	2.41	1.35	40.56
1897	1.72	2.13	3.49	3.57	3.81	2.88	6.70	2.80	2.55	0.59	4.45	3.41	38.10
1898	5.04	1.37	6.87	1.89	3.78	3.01	1.87	7.13	1.16	5.31	2.59	2.17	42.19
1899	2.04	1.85	4.03	1.74	3.86	3.68	3.81	3.84	3.46	-----	-----	-----	-----
Mean	2.83	2.68	3.28	2.68	4.21	3.64	4.43	3.57	2.91	2.35	2.89	2.80	38.63

Station discontinued in October, 1899.

Rowlesburg, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	4.89	2.98	2.37	3.15	1.90	1.35	2.56	3.87	0.75	6.07	2.79	0.37	33.05
1886	0.94	0.52	2.72	1.99	4.58	3.61	0.47	2.38	1.23	0.10	0.47	0.13	19.14
1887	3.35	2.23	2.30	4.80	3.80	5.15	2.34	3.39	4.10	1.57	2.37	1.88	37.28
1888	6.15	2.50	4.74	2.65	4.32	1.72	5.50	5.60	5.00	1.39	1.65	1.10	42.32
1889	2.71	1.56	0.95	3.23	2.05	5.30	5.17	1.67	2.86	2.36	4.83	3.05	35.74
1890	4.69	5.54	4.46	6.14	8.09	4.67	2.92	5.44	4.39	4.62	2.22	3.28	56.46
1891	2.52	5.62	4.08	4.20	4.25	3.79	4.70	5.49	1.62	2.69	4.16	5.93	49.05

Rowlesburg, W. Va.—(Continued)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	2.92	2.08	3.45	4.84	5.87	3.42	3.56	2.38	2.13	1.55	4.94	2.77	39.91
1893	2.14	3.84	1.06	5.70	4.48	3.87	3.82	2.00	1.78	3.41	1.96	2.20	36.26
1894	2.63	3.98	2.71	4.81	7.40	2.80	3.99	2.29	2.84	2.27	3.44	6.18	45.34
1895	2.98	0.99	4.26	4.78	2.08	3.40	4.34	1.89	0.42	1.15	2.75	2.75	31.79
1896	1.65	3.11	1.76	1.00	3.21	6.61	12.14	1.18	3.49	2.93	2.20	1.81	41.09
1897	2.20	5.08	4.29	4.07	3.60	4.57	4.47	4.52	1.95	0.65	6.70	7.24	49.34
1898	6.62	2.12	6.72	4.77	4.73	2.57	1.53	5.70	1.59	2.48	2.52	2.98	44.33
1899	3.94	3.30	6.78	2.31	5.72	7.69	4.70	2.96	2.85	0.80	3.49	3.10	47.64
1900	2.80	3.92	4.57	1.05	1.36	6.96	2.70	4.88	1.26	2.01	3.77	1.32	36.60
1901	3.05	1.54	4.01	5.02	2.71	4.20	3.13	4.31	2.68	0.53	3.60	7.10	41.88
1902	4.97	2.69	4.42	4.08	3.26	5.27	5.74	2.53	3.01	4.52	3.29	7.91	51.69
1903	4.34	6.55	5.06	4.24	3.48	7.63	4.10	3.65	1.54	3.33	2.83	3.09	49.84
1904	3.61	3.16	5.16	3.58	2.87	4.00	4.60	2.37	4.87	2.25	0.76	4.26	41.49
1905	3.98	2.99	6.14	3.63	4.67	6.32	7.68	5.76	2.53	5.35	3.49	3.14	55.68
1906	4.64	1.38	5.50	6.40	2.86	5.83	5.65	5.00	4.91	3.20	2.53	7.63	55.53
1907	10.07	3.87	7.17	3.86	5.54	5.76	12.84	5.69	3.65	4.30	5.10	4.28	72.13
1908	3.70	5.21	8.60	5.20	10.10	3.91	5.00	3.02	0.85	0.33	0.82	4.29	51.03
1909	4.30	5.00	4.37	5.82	3.28	8.94	4.52	5.04	3.18	4.86	1.83	3.89	55.03
1910	8.33	3.10	0.78	3.81	4.39	8.18	3.26	1.72	4.32	2.12	3.02	3.25	46.28
Mean	4.00	3.26	4.17	4.04	4.26	4.90	4.67	3.64	2.68	2.57	2.98	3.65	44.84

Saegerstown, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	5.00	4.24	2.27	1.73	8.95	7.73	3.50	4.76	3.44	2.93	3.97	2.90	51.42
1893	4.06	8.23	2.94	4.43	8.89	3.25	2.13	5.20	0.72	3.00	3.04	3.71	49.60
1894	2.57	2.70	1.74	2.55	4.92	1.59	1.47	0.98	6.14	2.31	2.61	2.39	31.97
1895	3.92	2.38	1.14	1.40	3.60	0.69	3.15	6.03	5.41	1.58	4.21	4.44	37.95
1896	1.33	4.10	3.42	2.95	1.66	6.97	5.48	3.29	4.31	2.25	3.71	2.01	41.48
1897	3.26	2.41	3.59	2.22	3.95	3.58	14.51	6.63	1.55	0.50	6.51	3.49	52.20
1898	4.87	3.02	4.30	2.08	4.00	5.12	3.62	8.25	3.31	4.20	4.78	3.09	50.64
1899	2.67	2.03	3.63	1.34	5.95	2.14	5.84	0.54	5.25	0.79	2.05	5.30	37.53
1900	2.71	6.96	2.81	1.58	2.78	3.13	4.77	1.74	2.81	2.87	5.95	2.89	41.00
1901	2.52	1.74	5.21	4.83	4.62	5.63	2.25	7.15	6.53	1.28	3.80	3.33	48.89
1902	2.43	1.49	2.41	4.21	4.36	6.11	9.28	1.91	3.61	3.99	2.03	4.11	45.94
1903	2.88	4.58	4.44	3.44	2.71	4.85	5.54	8.05	1.48	5.07	2.98	2.61	48.63
1904	4.60	3.28	6.46	3.92	6.22	3.90	4.54	3.52	3.61	3.15	1.25	2.43	46.88
1905	2.14	1.97	2.47	3.07	4.01	4.71	5.17	6.04	3.02	4.08	3.29	2.35	42.32
1906	1.63	1.22	3.57	3.21	3.08	5.64	3.28	3.17	6.57	6.71	2.93	3.93	44.94
1907	5.29	1.42	3.80	3.10	3.75	7.49	3.75	2.67	5.35	4.56	3.80	3.94	48.92
1908	3.03	4.48	4.16	4.13	7.23	2.90	3.36	1.22	0.79	1.40	1.76	4.32	38.78
1909	3.30	4.79	2.89	5.49	3.88	7.97	2.64	2.82	2.18	1.73	a2.49	2.36	42.54
1910	5.54	-----	0.68	-----	3.37	1.73	4.83	1.83	4.05	5.23	5.50	3.46	-----
Mean	3.36	3.41	3.26	3.09	4.88	4.68	4.89	4.20	3.68	3.03	3.51	3.32	44.53

a. Estimated from surrounding stations.

Saltsburg, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1884	1.62	4.85	-----	0.83	-----	-----	-----	-----	-----	-----	1.42	4.03	-----
1885	2.71	0.55	-----	0.83	5.88	8.26	4.35	5.93	2.57	3.97	1.48	0.36	-----
1886	3.16	0.47	1.09	1.70	1.82	1.09	1.58	2.06	3.89	0.56	4.13	0.72	22.27
1887	0.45	2.37	0.79	2.60	4.10	6.70	2.56	2.23	2.34	0.93	2.25	1.70	29.02
1888	7.73	1.66	3.25	1.64	4.26	2.45	-----	-----	-----	4.38	2.50	2.22	-----
1889	2.39	2.26	2.91	4.67	5.40	4.93	3.03	2.79	3.93	2.30	5.43	3.69	43.73
1890	4.98	6.97	5.54	4.50	5.48	2.96	2.03	5.07	6.08	6.89	1.87	5.91	58.28
1891	3.63	7.20	3.63	2.24	4.01	2.77	6.02	2.55	1.71	2.26	2.83	4.68	43.53
1892	4.04	2.83	2.92	2.49	4.01	4.86	4.66	2.72	1.13	0.57	2.59	2.49	35.31
1893	2.25	4.44	0.71	4.40	4.94	4.19	2.01	2.76	1.81	2.79	1.66	3.04	35.00

Saltsburg, Pa.—(Continued)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1894	2.55	3.29	2.10	2.56	4.46	1.99	1.86	1.54	6.58	1.93	2.14	4.47	35.47
1895	4.83	1.35	2.30	4.22	2.11	2.77	6.16	3.70	3.34	1.00	2.04	-----	-----
1902	2.62	1.75	4.16	3.82	1.49	4.94	4.98	2.10	2.02	3.43	1.00	4.69	37.00
1903	3.00	4.04	3.97	3.42	1.15	4.78	-----	3.77	3.88	2.90	2.67	1.92	-----
1904	3.40	3.34	5.44	5.17	3.56	4.12	4.88	3.39	1.79	2.24	0.56	2.73	40.62
1905	3.20	1.54	3.63	4.24	3.21	4.75	5.20	4.24	3.20	3.83	-----	3.24	-----
1906	1.54	0.86	2.96	1.05	2.39	5.14	4.80	7.76	2.64	2.81	0.99	3.26	36.20
1907	5.66	1.59	5.50	1.74	2.08	4.08	6.08	3.28	5.62	2.70	2.50	3.43	44.26
1908	2.80	3.88	6.38	3.66	6.00	2.65	5.15	2.44	0.68	0.74	0.76	3.40	38.60
1909	2.99	4.71	3.88	6.04	2.81	4.42	1.66	6.42	2.86	2.74	1.14	2.59	42.26
1910	7.87	3.98	0.56	3.69	2.59	2.25	2.29	2.04	6.41	1.82	1.90	3.06	38.46
Mean	3.50	3.04	3.25	3.08	3.54	4.01	3.85	3.51	3.29	2.54	2.09	3.08	38.66

No records 1896–1901.

Skidmore, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1904	2.60	2.34	4.15	5.01	4.92	3.58	4.22	6.35	1.41	1.77	0.76	2.29	39.40
1905	2.46	2.30	3.61	2.33	4.12	4.47	6.54	4.54	3.16	3.53	2.20	2.38	41.64
1906	1.67	1.15	3.06	2.07	2.60	-----	-----	3.91	-----	3.24	1.54	1.69	-----
1907	a4.04	1.11	2.58	2.91	2.14	4.08	3.03	1.30	3.45	2.18	1.70	1.90	30.42
1908	2.63	2.70	4.45	2.20	5.05	2.45	3.65	2.70	0.95	1.60	1.00	2.10	31.48
1909	4.25	4.35	2.35	5.25	2.00	5.50	1.95	1.20	1.80	0.95	1.50	2.14	32.24
1910	7.50	4.20	a0.20	3.50	3.10	2.95	2.35	0.55	6.75	1.85	1.10	2.45	36.50
Mean	3.59	2.59	2.94	3.32	3.42	3.84	3.62	2.94	2.92	2.16	1.40	2.14	35.28

a. Estimated from surrounding stations.

Smethport, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1839	-----	2.83	3.32	1.46	4.39	5.48	7.37	1.46	2.85	0.42	2.36	7.30	-----
1840	1.53	2.17	5.07	2.74	2.43	3.94	2.40	5.10	2.93	3.58	2.33	2.30	36.57
1841	4.60	0.96	-----	-----	1.32	-----	2.26	2.41	-----	-----	-----	-----	-----
1888	-----	-----	-----	-----	-----	5.02	1.41	6.78	3.63	7.66	4.01	2.21	-----
1889	-----	2.72	-----	-----	9.21	5.93	-----	-----	-----	-----	-----	-----	-----
1891	-----	-----	-----	-----	-----	5.66	8.14	5.15	2.15	-----	-----	-----	-----
1893	-----	-----	-----	4.60	4.90	3.68	3.56	4.15	2.92	3.65	2.83	6.07	-----
1894	4.20	3.35	1.86	4.22	11.33	3.65	2.03	3.15	6.32	3.37	2.52	3.45	49.45
1895	4.10	1.10	2.35	2.46	2.12	4.00	2.83	3.27	2.08	0.83	3.45	3.85	32.44
1896	1.60	3.55	4.23	1.88	3.34	5.38	7.19	2.27	6.82	3.52	2.41	1.85	44.04
1897	1.60	2.75	4.22	3.43	2.90	2.95	-----	3.25	-----	0.65	5.93	3.25	-----
1898	3.42	1.35	5.57	2.35	4.59	4.50	2.30	6.08	2.40	4.95	4.00	2.10	43.61
1899	2.30	2.85	3.60	1.40	5.33	2.68	5.40	1.70	-----	2.58	1.88	-----	-----
1900	2.52	1.00	3.65	1.25	1.88	1.98	3.65	2.90	1.67	5.10	4.65	0.40	30.65
1901	2.40	0.60	4.10	5.70	5.16	3.73	4.70	5.64	5.27	1.10	4.50	4.45	47.35
1902	-----	1.80	2.35	2.75	3.30	-----	9.33	1.25	2.23	2.12	2.75	-----	-----
1903	4.20	4.90	4.00	2.49	2.70	-----	-----	6.14	3.40	3.11	3.23	1.61	-----
1904	-----	-----	3.55	2.34	4.30	3.45	4.29	6.66	6.36	2.81	0.75	1.85	-----
Mean	2.95	2.28	3.68	2.79	4.32	4.14	4.46	3.96	3.65	3.03	3.17	3.13	41.56

No records for September, 1841 to May, 1888, inclusive, or for 1890 and 1892.
Station discontinued after 1904.

Smithfield, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1903	-----	-----	5.51	-----	2.19	4.48	3.62	-----	-----	-----	-----	-----	-----
1904	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.98	0.44	3.00	-----
1905	3.36	1.50	3.29	3.72	3.91	7.45	5.50	6.04	2.99	6.04	2.81	3.88	50.49
1906	4.07	1.60	4.93	3.79	1.79	4.17	2.94	3.17	2.84	2.73	2.84	7.38	42.25
1907	8.13	2.25	5.93	3.21	2.46	3.71	8.09	5.49	2.75	2.73	3.25	3.77	51.77
1908	3.12	5.07	6.91	3.36	8.13	1.47	6.93	3.12	1.70	1.38	1.70	4.77	47.66
1909	6.59	6.24	2.47	6.13	5.74	7.96	2.57	4.08	1.07	4.11	1.07	3.64	51.67
1910	5.31	5.64	0.10	3.84	4.56	2.62	6.78	1.22	3.29	1.93	2.75	2.01	40.05
Mean	5.09	3.72	4.16	4.01	4.11	4.55	5.20	3.85	2.44	2.82	2.12	4.06	47.31

Somerset, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1840	2.10	1.71	1.86	4.70	3.97	3.06	3.35	3.41	1.55	2.97	1.67	3.04	33.39
1841	2.08	1.00	2.17	2.54	2.83	5.50	2.43	0.80	3.38	1.96	3.00	3.66	32.35
1846	4.51	3.70	1.88	2.96	6.61	6.80	3.03	3.54	3.05	3.11	4.23	1.10	44.52
1856	-----	-----	-----	-----	3.29	3.95	1.54	4.24	1.56	2.43	3.40	1.62	-----
1857	-----	-----	-----	-----	-----	-----	2.96	5.13	3.28	3.31	2.38	4.28	-----
1858	0.98	2.22	1.13	3.96	8.39	4.03	3.07	1.32	1.34	2.06	3.91	4.94	37.35
1859	1.66	4.39	3.28	5.54	1.66	3.80	1.76	3.71	4.68	1.16	1.26	3.90	36.86
1860	2.68	1.67	1.57	5.78	6.73	3.18	5.16	5.12	2.57	5.44	6.09	3.33	49.32
1861	2.80	1.71	2.09	4.34	4.04	2.42	3.60	3.52	5.45	3.94	5.01	1.15	40.07
1888	6.40	1.34	3.25	2.54	5.85	2.76	4.30	7.68	3.26	5.47	2.74	2.21	47.80
1889	3.48	3.13	2.52	4.55	8.32	3.87	5.06	3.35	2.94	2.61	7.22	4.29	51.34
1890	5.60	4.51	5.42	3.16	8.90	4.93	2.36	7.90	7.84	7.12	3.00	5.52	66.26
1891	5.51	5.50	5.37	1.13	4.10	5.20	4.68	5.02	4.12	2.45	2.45	4.60	50.13
1892	3.05	2.95	3.85	4.43	5.28	4.40	3.97	2.09	1.42	0.32	6.17	3.32	41.25
1893	3.68	8.38	1.67	5.46	7.30	2.02	3.37	3.93	3.26	3.02	1.16	1.75	45.00
1894	3.19	5.20	1.85	10.00	14.33	3.32	3.50	1.05	3.12	3.20	2.70	5.69	57.15
1895	6.36	1.56	3.34	2.58	1.88	2.80	2.94	2.79	0.50	1.18	2.66	2.89	31.48
1896	1.71	4.24	4.72	3.27	3.01	7.68	10.55	2.75	6.50	2.72	3.84	2.62	52.61
1897	3.01	6.67	5.86	3.99	4.65	2.56	4.89	3.11	1.38	0.32	5.86	5.50	47.80
1898	6.87	3.11	5.38	4.51	3.91	2.44	4.72	9.31	1.87	5.37	2.91	4.79	55.19
1899	4.20	4.39	5.76	2.83	4.96	4.45	4.60	4.71	7.18	2.79	2.21	3.05	51.13
1900	3.44	5.69	7.31	2.80	3.67	10.29	4.31	4.80	0.60	2.15	6.46	4.16	55.68
1901	4.41	2.58	7.21	7.85	7.23	3.73	4.60	4.98	3.83	0.90	2.63	5.49	55.44
1902	5.15	5.65	7.50	7.14	3.85	4.45	4.74	2.72	1.69	4.25	2.44	6.81	56.39
1903	4.13	5.16	4.84	4.52	2.12	7.25	4.80	3.93	1.30	2.99	1.62	2.54	45.20
1904	5.82	4.29	5.10	5.81	3.46	6.26	7.44	2.36	2.72	1.91	1.80	3.47	50.44
1905	4.80	2.07	3.90	4.46	4.84	8.35	6.19	9.57	2.35	5.29	3.05	4.51	59.38
1906	5.28	1.79	7.35	3.26	2.85	6.53	4.60	11.17	3.57	2.47	3.08	4.75	56.70
1907	7.77	3.26	7.28	4.42	5.00	7.60	6.24	5.05	5.02	1.77	6.22	4.42	64.05
1908	5.33	7.72	7.50	5.25	7.26	3.12	5.17	1.80	0.91	0.55	1.97	3.29	49.87
1909	3.63	4.87	3.68	4.62	1.97	5.52	2.44	5.22	2.41	2.36	1.35	3.69	41.76
1910	8.91	4.09	0.99	4.89	3.34	8.68	2.65	2.40	a4.72	1.58	2.35	4.41	49.01
Mean	4.28	3.82	4.19	4.44	5.02	4.87	4.22	4.33	3.11	2.79	3.34	3.77	48.50

No records 1842-1845, 1847-1855 and 1862-1887.
a. Estimated from surrounding stations.

South Canisteo, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	3.20	1.40	1.30	4.96	5.90	7.19	9.25	3.12	4.57	4.59	6.35	4.00	55.83
1890	3.89	2.67	4.33	4.22	8.64	5.03	2.31	7.41	12.72	6.51	1.90	4.00	63.63
1891	2.53	4.72	3.43	2.22	1.41	2.68	4.62	5.80	1.20	3.48	2.74	3.30	38.18
1892	3.50	3.40	3.42	1.57	6.74	3.99	4.56	4.83	1.40	2.44	3.60	1.01	40.46
1893	2.96	3.58	3.51	5.84	5.25	4.78	2.70	4.13	2.76	4.05	2.03	2.91	44.50
1894	3.41	3.21	1.64	7.80	11.46	3.51	3.34	2.71	7.12	4.40	2.13	3.41	54.14
1895	3.32	0.97	1.63	1.49	2.79	4.75	2.77	3.88	1.15	1.17	3.39	4.34	31.65
1896	2.76	5.62	3.62	1.25	4.03	6.22	5.01	1.62	5.10	6.49	1.82	1.14	44.68
1897	2.34	1.60	3.01	3.13	3.18	3.48	5.62	2.69	3.47	1.04	3.56	2.71	35.83

South Canisteo, N. Y.—(Continued)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1898	3.90	2.09	4.53	3.35	3.87	2.90	1.75	4.45	2.28	4.80	3.33	2.62	39.87
1899	1.99	1.95	2.60	1.51	3.29	2.48	2.99	1.99	3.15	3.21	1.80	4.27	31.23
1900	2.40	5.62	2.62	1.60	3.05	5.11	4.10	3.37	1.43	5.81	6.03	1.60	42.74
1901	1.95	1.32	3.13	7.07	5.15	3.53	3.97	5.93	3.24	0.62	2.64	4.66	43.21
1902	2.90	2.37	2.73	2.86	1.77	6.24	8.40	2.56	3.32	1.49	1.41	3.05	39.10
1903	3.25	2.15	4.64	3.24	1.94	5.49	4.59	7.13	1.98	4.47	2.48	1.38	42.74
1904	3.45	3.85	3.15	2.81	5.06	2.03	4.20	3.80	3.01	2.46	1.05	2.10	36.97
1905	3.80	1.30	2.70	3.03	1.52	5.37	3.91	2.24	2.40	3.66	2.03	2.93	34.89
1906	1.54	0.98	3.17	1.95	3.29	3.75	3.66	5.69	3.32	5.88	1.70	2.56	37.49
1907	3.25	1.40	2.01	4.11	2.93	3.95	4.16	1.49	4.16	3.43	2.04	2.87	35.80
1908	2.38	3.20	3.59	3.72	4.48	2.89	5.58	3.21	1.48	2.38	1.06	1.70	35.67
1909	2.70	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Mean	2.92	2.67	3.04	3.39	4.29	4.27	4.37	3.90	3.46	3.62	2.65	2.83	41.43

Station discontinued in 1909.

Spencer, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	-----	3.20	5.30	4.12	5.00	4.87	2.48	0.71	2.05	-----	2.08	3.22	-----
1893	7.06	5.84	1.23	4.60	2.68	3.85	3.71	2.01	1.33	5.60	0.47	0.68	39.06
1894	4.26	3.97	1.22	2.81	3.88	1.39	1.12	0.60	2.80	2.90	0.77	6.02	29.94
1895	5.10	1.00	3.90	1.00	1.80	2.46	4.00	2.70	4.25	1.45	4.00	2.00	33.66
1896	1.70	2.16	4.66	2.80	1.60	2.91	7.10	2.70	3.85	2.75	3.90	1.95	37.18
1899	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.19	2.83	-----
1900	2.78	3.77	3.17	1.08	3.94	4.46	5.11	2.88	1.15	2.28	4.77	2.51	37.90
1901	2.56	1.66	2.99	8.83	4.87	11.10	1.21	3.88	4.37	2.07	3.13	6.09	52.76
1902	4.21	-----	-----	4.02	5.21	-----	-----	-----	-----	-----	-----	-----	-----
1903	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.72	2.06	-----
1904	2.61	2.85	-----	2.34	-----	-----	-----	-----	-----	-----	-----	-----	-----
1906	3.06	2.54	5.01	1.20	2.70	7.05	6.63	5.30	4.11	2.59	2.80	4.23	47.22
1907	6.69	1.99	4.14	3.90	4.44	4.73	5.49	7.73	3.94	2.35	1.41	1.77	48.58
1908	2.17	4.15	7.76	3.64	5.18	2.59	6.41	2.36	0.51	1.61	0.86	2.28	39.52
1909	2.97	3.89	3.25	4.38	4.68	3.92	4.69	2.49	1.12	2.28	1.29	2.04	37.00
1910	6.83	3.73	-----	3.60	5.06	6.57	3.83	0.70	6.04	1.49	1.78	3.35	42.98
Mean	4.00	3.13	3.55	3.46	3.85	4.66	4.31	2.84	2.96	2.49	2.16	2.93	40.53

No records for 1897, 1898 and 1905.

Springdale, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1905	-----	-----	3.67	3.32	3.72	7.28	5.72	3.45	3.16	4.14	2.97	3.84	-----
1906	2.61	1.35	3.47	2.10	2.82	3.89	5.12	7.41	5.25	4.01	1.36	3.31	42.70
1907	5.87	1.35	6.20	2.30	2.76	4.19	5.09	2.85	4.15	2.82	2.11	3.47	43.16
1908	2.00	3.01	6.91	3.88	5.88	2.65	3.52	4.16	1.18	0.95	0.66	3.03	37.83
1909	3.16	4.91	3.83	5.34	2.48	5.28	2.19	2.14	1.56	2.35	1.03	2.53	36.80
1910	6.36	4.34	0.79	2.97	2.84	2.95	2.14	2.30	4.54	2.20	1.70	2.64	35.77
Mean	4.00	2.99	4.15	3.32	3.42	4.37	3.96	3.72	3.31	2.75	1.64	2.70	39.25

St. Marys, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	2.62	4.10	2.39	3.47	2.39	6.56	8.65	1.43	2.23	1.65	0.55	-----	-----
1903	2.87	-----	-----	3.90	1.90	4.90	7.20	4.56	1.68	3.70	5.33	3.35	-----
1904	4.50	2.82	4.25	3.25	3.75	3.91	3.82	2.87	4.08	3.10	0.45	1.77	38.57
1905	2.50	1.25	3.76	3.75	2.43	4.33	4.50	5.60	3.23	5.51	3.07	4.67	44.65

St. Marys, Pa.—(Continued)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1906	2.96	0.58	5.26	3.14	3.96	3.53	2.69	5.62	3.51	3.89	1.48	a3.89	40.41
1907	3.64	-----	-----	-----	2.20	5.65	-----	1.37	5.55	3.77	2.43	2.34	-----
1908	2.87	5.25	a5.15	4.72	8.87	2.60	5.70	2.36	1.21	0.66	1.02	2.68	43.12
1909	3.04	6.89	2.65	5.09	3.07	4.38	3.05	0.38	2.11	3.04	2.29	2.97	38.96
1910	3.99	2.37	1.05	3.36	3.25	-----	-----	-----	-----	-----	-----	-----	-----
Mean	3.22	3.32	3.50	3.83	3.54	4.48	5.09	3.02	2.95	3.16	2.08	3.17	41.43

a. Estimated from surrounding stations.

Terra Alta, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1899	-----	-----	-----	-----	6.82	8.19	3.61	1.72	6.13	1.50	-----	-----	-----
1900	2.37	3.05	3.79	1.50	1.50	7.78	5.55	7.20	1.00	2.00	5.20	1.50	42.44
1901	-----	1.05	4.80	-----	-----	-----	-----	-----	-----	-----	2.55	5.40	-----
1902	4.60	3.30	5.20	4.15	2.10	7.40	6.45	4.10	3.05	5.50	4.18	8.85	58.88
1903	5.60	6.90	4.60	2.50	5.28	12.30	8.30	3.00	0.64	4.75	3.90	3.70	61.47
1904	3.20	1.64	5.96	4.14	4.42	4.20	5.50	2.93	4.48	2.25	0.40	4.37	43.49
1905	7.43	2.59	6.82	2.59	7.57	7.72	7.33	7.50	2.75	5.28	4.26	1.83	63.67
1906	3.96	1.05	5.45	6.59	3.82	6.11	7.00	6.06	2.35	4.35	4.13	11.15	62.02
1907	7.28	4.16	7.36	2.92	6.37	5.05	10.83	5.70	7.03	4.73	4.77	9.31	75.51
1908	4.04	6.26	7.07	3.83	9.99	3.31	6.52	3.49	1.98	0.69	0.61	4.00	51.79
1909	5.00	7.68	6.56	7.09	4.43	9.19	3.50	2.96	2.81	4.53	2.11	6.00	61.36
1910	9.19	5.53	0.17	4.68	5.05	8.21	4.40	1.59	-----	-----	-----	-----	-----
Mean	5.27	3.93	5.26	4.00	5.21	7.22	6.27	4.20	3.22	3.56	3.21	5.61	57.90

Uniontown, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1888	5.69	1.26	3.00	1.42	4.72	4.65	7.10	10.23	2.84	5.16	3.36	2.67	52.10
1889	2.34	2.43	3.60	4.47	6.93	7.36	4.81	3.86	3.79	3.31	8.90	2.76	54.56
1890	6.10	4.73	6.27	3.90	8.03	4.33	5.65	8.44	6.73	7.41	2.25	6.84	70.68
1891	3.41	6.64	4.22	2.18	3.35	8.63	5.75	3.85	2.23	2.99	3.65	4.22	51.12
1892	4.34	2.62	2.49	3.23	6.48	7.70	7.11	2.40	2.21	1.05	3.50	1.55	44.68
1893	2.23	4.23	0.98	6.11	5.68	2.34	a2.35	a3.22	1.30	3.22	2.34	4.11	38.11
1894	2.88	3.35	2.90	3.56	6.82	1.40	2.77	1.42	5.77	2.41	2.96	5.19	41.43
1895	4.89	1.39	3.86	4.12	2.07	4.55	5.61	3.76	1.22	1.44	2.87	2.87	38.65
1896	2.14	3.15	4.61	2.62	3.16	3.12	15.59	2.82	3.78	3.64	3.22	1.61	49.40
1897	1.93	5.73	a3.96	4.63	4.52	2.98	6.83	2.15	1.92	0.22	6.24	4.30	45.41
1898	5.62	1.73	5.26	4.19	3.46	3.27	6.06	6.13	1.54	5.83	3.99	3.64	50.72
1899	4.28	4.51	5.67	1.37	5.09	3.07	6.44	3.38	8.17	1.76	3.18	3.82	50.74
1900	2.32	3.96	4.54	1.85	2.72	5.67	6.55	5.20	a1.45	4.15	6.92	2.21	47.54
1901	3.00	0.67	4.86	8.55	6.25	7.61	2.38	3.68	4.46	0.46	3.74	7.12	52.78
1902	2.57	2.66	5.66	5.48	3.10	5.95	6.81	2.63	3.01	3.65	1.59	4.75	47.86
1903	1.68	4.73	3.84	3.55	2.56	6.03	4.32	3.25	1.21	2.92	2.15	1.81	38.05
1904	2.83	2.61	4.32	3.72	3.64	2.52	3.29	3.61	1.99	1.27	0.25	1.89	31.94
1905	3.64	1.36	a4.72	2.84	3.18	5.26	5.21	3.70	2.03	5.56	3.00	5.48	45.98
1906	4.35	1.88	5.15	2.41	1.77	3.95	2.00	8.23	2.69	2.87	1.73	3.62	42.65
1907	6.52	3.17	7.89	2.15	3.64	5.20	6.41	4.80	4.24	3.08	3.83	3.67	54.60
1908	2.21	4.14	6.84	4.83	5.11	4.16	2.66	4.02	0.63	0.57	0.67	2.91	38.75
1909	3.70	4.13	3.04	5.73	3.22	5.65	4.03	5.70	1.33	3.44	0.64	2.43	43.04
1910	7.97	3.44	0.41	2.73	3.86	4.33	2.84	2.24	4.07	1.48	2.51	3.62	44.82
Mean	3.77	3.24	4.27	3.72	4.32	4.77	5.33	4.29	2.96	2.95	3.19	3.61	46.76

a. Estimated from surrounding stations.

Volusia, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1899	-----	-----	-----	-----	5.07	2.57	4.95	2.18	8.27	2.45	1.95	-----	-----
1900	3.08	3.93	3.27	1.65	2.44	1.46	5.21	1.54	4.46	3.40	7.02	3.25	40.71
1901	3.41	1.74	3.43	6.20	4.29	4.06	2.01	3.32	6.31	2.35	5.50	4.48	47.10
1902	2.79	3.17	1.81	2.04	3.56	5.63	8.94	0.79	4.89	4.01	0.78	3.33	41.74
1903	3.18	2.66	2.51	3.10	1.47	6.05	4.50	5.18	3.33	3.46	5.54	3.93	43.91
1904	5.71	3.99	3.87	2.96	3.23	1.16	4.07	2.62	1.92	4.03	1.07	2.42	37.05
1905	2.64	1.49	1.38	1.40	2.60	5.98	3.83	5.35	2.31	4.35	5.02	1.81	38.16
1906	1.11	0.71	3.01	2.19	3.01	1.27	2.69	3.02	2.25	7.59	2.91	3.16	32.92
1907	4.60	1.01	1.61	2.09	3.79	3.64	2.27	0.86	4.30	5.70	3.80	4.55	38.22
1908	2.76	2.40	2.10	2.33	4.18	2.38	1.24	1.62	1.03	1.05	1.66	2.33	25.08
1909	1.83	4.94	2.33	4.32	4.39	4.65	2.61	4.28	5.91	2.89	2.56	3.63	44.34
1910	3.90	4.31	0.83	2.11	2.76	2.17	2.26	2.43	2.99	3.89	4.89	4.60	37.14
Mean	3.18	2.75	2.37	2.75	3.39	3.42	3.71	2.77	4.00	3.76	3.56	3.41	38.76

Warren, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1889	2.77	1.44	0.77	5.00	1.76	3.86	5.42	3.41	3.67	2.66	3.53	4.47	39.76
1890	4.34	3.68	3.66	5.09	8.19	4.71	2.24	5.97	8.70	6.62	2.82	2.20	58.22
1891	2.27	5.88	2.54	1.70	1.97	3.58	12.54	4.74	2.66	3.10	5.79	4.60	51.37
1892	2.03	3.20	1.46	1.98	9.96	7.91	4.20	4.83	2.52	2.36	3.86	2.36	47.57
1893	2.76	5.51	3.01	4.10	6.28	4.82	1.79	6.44	1.28	3.53	3.28	5.91	48.71
1894	3.03	2.89	1.87	3.03	9.21	3.09	2.88	1.31	6.14	3.30	3.64	2.87	43.26
1895	3.22	0.94	1.42	3.05	2.36	2.70	2.92	4.65	2.12	1.82	5.73	2.61	33.54
1896	1.32	3.62	3.86	2.69	3.23	4.07	6.38	2.99	6.03	2.72	2.64	1.68	41.23
1897	2.27	1.53	2.60	3.21	4.20	2.50	6.15	4.09	1.63	0.13	6.60	2.60	37.51
1898	2.75	1.69	3.82	3.02	4.23	5.95	2.90	7.73	2.63	5.13	4.30	3.17	47.32
1899	3.40	3.38	4.35	1.64	6.40	2.58	5.73	1.39	7.19	1.44	1.92	6.00	45.42
1900	4.37	4.66	2.38	2.09	2.16	4.11	6.07	3.63	1.56	2.29	5.85	2.17	41.34
1901	3.06	1.18	3.66	2.53	3.66	4.62	6.00	8.82	3.59	1.29	5.00	3.10	46.51
1902	1.26	1.57	1.36	2.51	4.45	5.79	9.90	0.68	4.29	2.89	1.40	4.57	40.67
1903	2.55	1.80	4.09	3.24	3.68	4.28	6.06	4.46	2.32	3.66	2.71	2.00	40.85
1904	2.52	2.47	5.94	4.27	7.50	1.95	8.06	3.07	4.28	2.38	1.21	2.20	45.85
1905	3.47	0.98	4.04	4.09	3.47	6.25	8.84	3.88	3.67	5.13	3.45	3.88	51.15
1906	1.95	0.58	4.63	2.20	2.07	2.93	3.41	2.67	4.74	5.08	1.32	5.11	36.69
1907	4.71	0.86	2.97	3.42	4.78	4.69	3.00	2.24	5.26	3.82	2.98	3.00	41.73
1908	3.14	4.79	3.64	3.86	5.00	4.16	3.40	1.66	1.40	0.52	1.64	2.85	36.06
1909	3.57	4.56	3.36	6.44	3.46	5.82	2.78	3.32	1.68	2.96	2.40	2.54	42.89
1910	4.52	3.76	0.82	3.84	3.02	1.98	4.90	2.90	2.92	3.92	5.06	2.74	40.38
Mean	2.97	2.77	3.01	3.32	4.59	4.19	5.25	3.86	3.65	3.03	3.51	3.30	43.55

Westfield, N. Y.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1896	2.00	4.65	2.58	1.22	1.94	2.90	3.07	4.05	4.73	1.40	4.81	1.36	34.71
1897	1.93	1.59	1.84	2.99	3.48	1.80	8.21	3.64	0.58	1.72	4.60	2.71	35.09
1898	2.56	2.60	2.78	2.74	4.19	6.17	2.68	2.46	2.46	4.31	2.85	3.29	39.09
1899	1.23	1.35	2.98	1.01	4.30	2.42	2.80	1.18	7.02	2.61	1.59	3.26	31.75
1900	3.60	3.16	1.43	0.64	2.44	2.03	5.75	1.39	2.61	3.29	6.22	1.70	34.26
1901	2.10	0.92	1.86	4.83	4.15	6.30	2.51	3.44	4.51	1.71	4.40	4.64	41.37
1902	1.95	1.44	1.48	2.93	5.42	4.41	8.52	1.26	4.33	3.10	1.62	2.83	39.29
1903	1.27	3.33	3.11	3.09	1.61	4.91	5.85	4.95	2.30	2.73	3.95	2.82	40.32
1904	4.51	3.03	3.58	2.30	3.89	1.05	3.23	2.54	1.99	3.91	0.71	1.98	32.72
1905	2.59	2.15	2.13	2.31	4.01	6.25	4.94	6.17	3.27	7.00	5.22	2.80	48.84
1906	1.65	1.52	3.12	2.15	2.98	2.02	2.68	2.58	2.48	8.64	3.63	2.68	36.13
1907	5.07	1.00	2.68	2.12	5.08	4.04	2.98	1.40	4.35	6.85	2.63	3.80	42.00
1908	2.73	2.43	3.22	3.69	5.54	3.18	2.06	2.50	0.60	1.35	2.19	1.90	31.39
1909	4.02	3.72	2.81	4.56	4.43	1.84	2.85	4.84	5.70	2.80	2.81	3.46	43.84
1910	4.48	4.98	0.72	3.29	4.61	2.70	3.52	2.38	3.83	3.91	3.31	3.79	41.52
Mean	2.78	2.52	2.42	2.66	3.87	3.43	4.11	2.99	3.38	3.69	3.37	2.87	38.12

West Newton, Pa.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1902	2.67	2.40	4.12	4.33	1.76	4.52	6.82	1.42	1.52	5.25	1.27	6.02	42.10
1903	3.52	5.67	4.80	3.03	1.90	6.48	6.06	3.95	1.74	3.15	2.30	2.36	44.96
1904	3.30	3.04	4.63	4.52	3.42	4.56	3.94	2.75	1.11	1.58	0.19	3.32	36.36
1905	2.90	2.10	4.66	3.44	2.94	7.66	7.74	3.30	2.96	3.92	2.59	4.02	48.23
1906	2.14	1.23	3.33	1.84	1.71	5.59	4.22	8.60	1.84	3.22	0.74	3.44	37.90
1907	6.08	1.74	6.65	2.00	2.85	4.28	4.54	4.34	5.14	2.00	1.87	3.34	44.83
1908	2.68	3.13	7.26	3.47	4.32	2.44	4.46	1.74	0.96	0.72	1.01	3.18	35.37
1909	3.32	5.00	3.16	5.32	2.81	3.30	2.57	7.76	1.34	2.99	0.65	2.47	40.69
1910	6.93	3.38	0.34	2.88	3.00	4.46	1.74	3.40	4.06	1.35	1.70	3.82	37.06
Mean	3.73	3.08	4.33	3.43	2.93	4.81	4.68	4.14	2.30	2.69	1.37	3.55	40.83

Weston, W. Va.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1888	4.92	2.54	4.21	4.03	4.46	3.49	2.65	3.90	-----	4.02	1.71	1.99	-----
1889	2.99	2.31	1.54	4.99	1.77	3.96	6.10	1.31	4.16	3.54	9.71	2.10	44.48
1890	4.15	5.73	4.80	4.75	9.06	8.21	4.03	7.94	5.64	7.84	2.94	3.11	68.20
1891	4.29	5.90	5.67	6.74	4.58	6.76	7.03	9.85	4.07	2.30	4.61	4.80	66.70
1892	2.56	3.50	4.87	5.88	6.06	2.30	4.85	6.95	3.10	1.03	4.06	3.60	48.76
1893	1.93	4.52	1.30	5.61	3.02	5.23	3.96	2.06	2.40	4.20	2.70	2.25	39.18
1894	2.60	3.90	1.98	4.46	5.31	3.10	2.48	2.64	3.05	3.30	2.65	5.31	40.78
1895	5.86	2.29	4.75	5.61	1.73	2.62	3.91	1.50	1.69	0.75	2.87	2.70	36.28
1896	2.72	3.00	4.61	1.95	3.39	7.03	15.15	3.86	4.02	4.37	3.57	2.50	56.17
1897	2.36	6.40	3.92	3.28	5.00	5.34	8.00	3.00	1.64	0.10	6.71	5.26	51.01
1898	7.55	3.15	10.05	3.11	3.42	3.44	3.81	6.77	3.84	5.63	3.50	3.13	57.40
1899	5.33	3.72	6.53	1.69	5.70	5.65	5.51	3.28	4.04	0.57	2.76	3.85	48.63
1900	2.46	5.06	4.24	1.67	4.43	6.21	4.11	2.98	0.88	3.54	5.50	2.88	43.96
1901	2.69	1.11	3.88	7.84	6.21	4.51	2.00	4.86	3.75	0.30	3.19	6.54	46.88
1902	4.17	2.91	4.44	3.44	3.34	5.17	5.76	2.69	2.56	3.59	3.71	7.34	49.12
1903	3.01	6.55	4.78	4.20	5.16	4.96	2.39	2.84	1.70	3.16	3.03	2.74	44.52
1904	3.09	2.91	5.20	4.43	2.50	4.04	1.92	1.48	0.46	1.30	0.46	3.39	31.18
1905	4.34	3.19	5.71	4.29	5.68	2.13	5.84	3.39	2.02	5.97	3.36	3.60	49.52
1906	4.64	3,34	6.54	4.42	2.83	6.34	3.76	3.39	2.27	2.34	2.98	6.08	48.93
1907	8.41	3.25	5.33	3.54	4.67	5.90	11.14	5.36	5.80	3.22	3.14	3.95	63.71
1908	3.34	5.24	6.46	4.84	7.54	4.42	4.88	0.90	1.11	1.06	1.04	3.76	44.59
1909	3.74	5.52	3.61	4.84	3.30	3.92	2.54	2.94	1.98	3.72	2.40	3.26	41.77
1910	6.78	3.18	0.96	a1.88	a4.31	4.21	3.06	1.93	5.07	1.80	2.24	2.50	37.92
Mean	4.08	3.91	4.58	4.24	4.50	4.74	4.99	3.73	2.97	2.81	3.43	3.77	48.19

a. Estimated from surrounding stations.

TABLE No. 47.

ANNUAL PRECIPITATION RECORDS AT STATIONS ON THE ALLEGHENY AND MONONGAHELA BASINS.

Station	Period of record	Years of record	Full years of record	Rainfall in inches			Page
				Maximum	Minimum	Mean	
Aleppo, Pa.	1901–1910	10	10	54.71	34.69	40.44	46
Alfred, N. Y.	1852–1910	20	12	49.13	31.16	36.91	46
Allegany, N. Y.	1907–1910	4	2	43.85	35.51	40.10	47
Angelica, N. Y.	1856–1910	29	21	52.07	28.02	37.70	47
Arcade, N. Y.	1889–1907	19	11	48.81	31.54	40.88	47
Baldwin, Pa.	1906–1910	5	2	.....	.....	.....	48
Beaver Dam, Pa.	1902–1910	9	6	45.00	33.03	39.67	48
Bolivar, N. Y.	1896–1910	15	10	42.32	31.83	38.82	48
Brookville, Pa.	1885–1906	22	20	55.48	26.23	41.53	48
Buckhannon, W. Va.	1889–1910	22	13	67.55	35.19	52.30	49
California, Pa.	1902–1910	9	6	44.17	33.51	39.74	49
Cassandra, Pa.	1894–1907	14	13	48.24	38.06	42.46	50
Central Station, W. Va.	1891–1910	17	11	51.02	29.22	40.42	50
Clarion, Pa.	1888–1910	18	11	58.56	37.36	45.90	50
Claysville, Pa.	1904–1910	7	5	48.33	35.18	40.06	51

ANNUAL PRECIPITATION RECORDS AT STATIONS ON THE ALLEGHENY AND MONONGAHELA BASINS.—(Continued.)

Station	Period of record	Years of record	Full years of record	Rainfall in inches			Page
				Maximum	Minimum	Mean	
Colebrook, O.	1858–1909	24	13	44.70	28.62	34.30	51
Confluence, Pa.	1875–1910	36	34	60.19	31.38	44.69	52
Creston, W. Va.	1900–1910	11	10	47.67	23.44	38.43	52
Davis Island Dam, Pa.	1902–1910	9	9	38.44	31.30	35.52	53
Deer Park, Md.	1894–1910	17	12	56.59	23.59	44.46	53
Derry, Pa.	1896–1910	15	13	51.19	34.57	43.05	53
Dubois, Pa.	1891–1897	7	6	48.29	34.54	42.54	54
Elkins, W. Va.	1894–1910	17	17	65.37	38.82	48.61	54
Elwood Jc., Pa.	1902–1908	7	7	43.29	36.12	39.53	54
Erie, Pa.	1873–1910	38	37	55.04	26.72	37.97	54
Fairmont, W. Va.	1892–1910	19	19	56.68	32.62	42.54	55
Franklin, Pa.	1869–1910	36	31	59.72	31.70	40.94	56
Franklinville, N. Y.	1896–1910	15	13	49.60	31.34	41.12	56
Freeport, Pa.	1877–1910	34	31	57.93	30.83	42.20	57
Friendship, N. Y.	1867–1909	19	9	48.39	25.36	35.47	57
Glenville, W. Va.	1887–1910	24	23	68.64	30.25	47.26	58
Grafton, W. Va.	1892–1910	19	18	58.99	33.77	44.40	58
Grantsville, Md.	1894–1910	17	15	56.30	26.89	42.88	58
Greensboro, Pa.	1889–1910	22	22	65.15	33.76	42.50	59
Greensburg, Pa.	1908–1910	3	2	.....	.....	.....	59
Greenville, Pa.	1888–1910	17	10	49.96	28.43	40.68	59
Grove City, Pa.	1907–1910	4	4	42.72	35.95	39.86	60
Haskinville, N. Y.	1895–1910	16	15	37.25	27.70	32.69	60
Herr Island Dam, Pa.	1903–1910	8	8	38.70	32.90	35.93	60
Humphrey, N. Y.	1883–1902	20	19	59.49	30.70	44.45	61
Hunt, N. Y.	1904–1910	7	6	37.14	27.64	32.90	61
Indiana, Pa.	1903–1910	8	7	47.79	40.07	42.78	61
Irwin, Pa.	1902–1910	9	8	49.62	31.41	40.53	61
Jamestown, N. Y.	1850–1908	20	18	52.72	34.43	43.55	62
Johnstown, Pa.	1885–1910	26	24	57.39	37.55	45.10	62
Lock No. 4, Pa.	1886–1910	25	25	62.75	24.88	39.23	63
Lost Creek, W. Va.	1896–1909	14	14	53.74	33.56	43.90	63
Lycippus, Pa.	1893–1910	18	18	51.51	31.85	42.63	63
Mahoning, Pa.	1885–1895	11	9	51.38	28.84	37.80	64
Mannington, W. Va.	1901–1910	10	5	53.51	33.76	40.47	64
Morgantown, W. Va.	1873–1910	37	34	69.54	28.15	43.04	64
Mt. Morris, N. Y.	1885–1900	16	5	31.02	17.34	28.14	65
New Martinsville, W. Va.	1892–1910	19	16	55.58	30.26	40.33	65
New Waterford, O.	1855–1910	32	25	46.99	28.76	38.72	66
Nunda, N. Y.	1898–1903	6	1	.....	.....	.....	67
Oakland, Md.	1903–1910	8	6	52.68	31.71	43.79	67
Oil City, Pa.	1877–1905	25	23	50.62	22.80	41.99	67
Olean, N. Y.	1909–1910	2	2	.....	.....	.....	67
Orangeville, O.	1889–1910	21	18	46.35	23.76	33.07	68
Otto, N. Y.	1902–1910	9	2	.....	.....	.....	68
Parkers Landing, Pa.	1885–1910	26	25	57.29	32.52	42.86	68
Parsons, W. Va.	1899–1910	12	12	62.91	33.47	44.93	69
Philippi, W. Va.	1892–1910	19	18	62.07	32.51	46.42	69
Pickens, W. Va.	1877–1910	21	20	80.86	44.67	55.45	70
Pittsburgh, Pa.	1840–1910	68	63	50.61	25.73	36.10	70
Ridgway, Pa.	1891–1899	8	7	44.71	29.92	38.63	71
Rowlesburg, W. Va.	1885–1910	26	26	72.13	19.14	44.84	71
Saegerstown, Pa.	1892–1910	19	17	52.20	31.97	44.53	72
Saltsburg, Pa.	1884–1910	21	15	58.28	22.27	38.66	72
Skidmore, Pa.	1904–1910	7	5	41.64	30.42	35.28	73
Smethport, Pa.	1839–1904	20	8	49.45	30.65	41.56	73
Smithfield, W. Va.	1903–1910	8	6	51.77	40.05	47.31	74
Somerset, Pa.	1840–1910	32	29	66.26	31.48	48.50	74
South Canisteo, N. Y.	1889–1909	21	20	63.63	31.23	41.43	74
Spencer, W. Va.	1892–1910	19	11	52.76	29.94	40.53	75
Springdale, Pa.	1905–1910	6	5	42.70	35.77	39.25	75
St. Marys, Pa.	1902–1910	9	3	44.65	38.57	41.43	75
Terra Alta, W. Va.	1899–1910	12	9	75.51	42.44	57.90	76
Uniontown, Pa.	1888–1910	23	19	70.68	31.94	46.76	76
Volusia, N. Y.	1899–1910	12	11	47.10	25.08	38.76	77
Warren, Pa.	1899–1910	12	12	58.22	33.54	43.55	77
Westfield, N.Y.	1896–1910	15	15	43.84	31.39	38.12	77
West Newton, Pa.	1902–1910	9	9	48.23	35.37	40.83	78
Weston, W. Va.	1888–1910	23	21	68.20	36.28	48.19	78

APPENDIX No. 3.

STREAM-FLOW.

Introduction—Methods of Study—Future Work—List of Gaging Stations—Data for each Station—Relation between Rainfall and Run-off—Maximum and Minimum Discharge—U. S. Weather Bureau Stations.

INTRODUCTION.

One of the most important features of the work of the Flood Commission has been the collection of stream-flow data. A thorough knowledge of the discharge of the main rivers and their tributaries is essential in a comprehensive study of the effect of a system of storage reservoirs on high-water and low-water flow. Such information is also necessary in order to determine, for estimate purposes, the required storage and discharging capacity of the respective reservoir projects.

When the Flood Commission began its work, there were 15 gaging stations in operation on the Allegheny and Monongahela Basins. In October, 1909, through coöperation with the Water Supply Commission of Pennsylvania, 9 additional stations were established. In 1910, the Flood Commission established 3 stations in May and 3 in October. There are therefore 30 stations now in operation on the two basins, 15 of which are maintained and operated by the Flood Commission, which has also made discharge measurements at the other stations whenever possible.

METHODS OF STUDY.

To study the flow of a stream, a gage is installed at a suitable cross-section, and the stage of the water is read once or twice daily, and more often during floods, by an observer living nearby. A station is generally located at or near a bridge, so that discharge measurements can be conveniently made during high water. The discharge measurements are made at various gage heights between extreme high and low water, generally with a current meter, and sometimes, at very high stages, by means of floats. When the discharge measurements at a station are sufficient in number and range, a discharge curve is plotted, using the gage heights as ordinates and the discharges as abscissae. This curve furnishes a means of graphically interpolating between the individual measurements, and enables the construction of a rating table giving the discharges corresponding to gage heights within the range of the fluctuations of the stage at the station. By taking from this rating table the discharges corresponding to the respective daily gage heights, a table of daily discharges can be made, and a complete knowledge of the flow of the stream obtained for the period during which gage heights are available.

In locating a gaging station, it is important to select a point where the cross-section is of a permanent character, and the flow is not affected by obstructions above or below the station. At such a station, it is evident that the same gage height always represents approximately the same discharge; and hence, after a sufficient number of discharge measurements has been made, and a complete discharge curve and rating table constructed, it is necessary merely to continue the daily readings of the gage.

FUTURE WORK.

More complete stream-flow data than now exist should be available at the time of final designs and estimates; while, if a system of reservoirs is constructed, such knowledge will be essential for the effective operation of the various projects both to control floods and to obtain the greatest use of the impounded water for navigation and water power. For this reason, it is felt that the present gaging stations should be maintained and, if possible, additional stations established. When the Flood Commission is no longer able to operate these stations, it is important that some State or National agency be empowered to continue this work, in order that valuable long-term records may be available when needed.

GAGING STATIONS.

The following table shows the gaging stations at which discharge measurements have been made on the Allegheny and Monongahela Basins, together with the date of their establishment and the agency through which they are maintained. These stations are still in operation, except as noted.

TABLE No. 48.

GAGING STATIONS.

Stream	Station	Established	Maintained by	Page
ALLEGHENY BASIN				
Allegheny	Aspinwall, Pa.	May, 1907	Pgh. Bureau of Filtration	82
Allegheny	Kittanning, Pa.	Aug., 1904	Water Supply Com. of Penna.	84
Allegheny	Red House, N. Y.	Sept., 1903	N. Y. State Engr.	96
Kiskiminetas	Avonmore, Pa.	June, 1907	Water Supply Com. of Penna.	108
Loyalhanna	New Alexandria, Pa.	Oct., 1910	Flood Com. of Pgh.	117
Black Lick	Black Lick, Pa.	Aug., 1904(a)	Water Supply Com. of Penna.	120
Crooked	Hileman's Farm, Pa.	Oct., 1909	Flood Com. of Pgh.	130
Mahoning	Furnace Bridge, Pa.	Oct., 1909	Flood Com. of Pgh.	135
Red Bank	St. Charles, Pa.	Oct., 1909	Flood Com. of Pgh.	139
Clarion	Clarion, Pa.	Nov., 1884	(b)	141
French	Carlton, Pa.	Apr., 1908	Water Supply Com. of Penna.	169
Sugar	Wyattville, Pa.	May, 1910	Flood Com. of Pgh.	177
Cussewago	Meadville, Pa.	May, 1910	Flood Com. of Pgh.	180
N. Branch	Kimmeytown, Pa.	May, 1910	Flood Com. of Pgh.	183
Oil	Rouseville, Pa.	Oct., 1909	Flood Com. of Pgh.	186
Tionesta	Nebraska, Pa.	Oct., 1909	Flood Com. of Pgh.	190
Brokenstraw	Youngsville, Pa.	Oct., 1909	Flood Com. of Pgh.	195
Conewango	Frewsburg, N. Y.	Oct., 1909	Flood Com. of Pgh.	200
Kinzua	Dewdrop, Pa.	Oct., 1909	Flood Com. of Pgh.	204
MONONGAHELA BASIN				
Monongahela	Lock No. 4, Pa.	1885(c)	U. S. Engineers	209
Turtle	E. Pittsburgh, Pa.	Dec., 1907	Water Supply Com. of Penna.	210
Youghiogheny	Connellsville, Pa.	July, 1908	Water Supply Com. of Penna.	217
Youghiogheny	Confluence, Pa.	Sept., 1904	Water Supply Com. of Penna.	223
Youghiogheny	Friendsville, Md.	Aug., 1898(d)	U. S. G. S.	234
Laurel Hill	Confluence, Pa.	Sept., 1904	Water Supply Com. of Penna.	243
Casselman	Confluence, Pa.	Sept., 1904	Water Supply Com. of Penna.	254
Dunkard	Bobtown, Pa.	Oct., 1909	Flood Com. of Pgh.	265
Cheat	Uneva, W. Va.	July, 1899	U. S. G. S.	267
Shavers Fork	Parsons, W. Va.	Oct., 1910	Flood Com. of Pgh.	283

TABLE No. 48—(Continued.)

GAGING STATIONS.

Stream	Station	Established	Maintained by	Page
Buffalo	Barrackville, W. Va.	June, 1907(e)	U. S. G. S......................	(e)
Tygart Valley ..	Fetterman, W. Va...	June, 1907	U. S. G. S......................	284
Tygart Valley ..	Belington, W. Va....	June, 1907	U. S. G. S......................	291
Buckhannon....	Hall, W. Va.........	June, 1907(f)	U. S. G. S......................	(f)
West Fork	Enterprise, W. Va...	June, 1907	U. S. G. S......................	298
Elk............	Clarksburg, W. Va...	Oct., 1910	Flood Com. of Pgh..............	305

(a)—Discontinued July, 1906. Reëstablished January, 1907.

(b)—Gage installed and observer paid by U. S. Weather Bureau. Discharge measurements made by Water Supply Commission of Pennsylvania and Flood Commission of Pittsburgh. No gage heights were observed from November, 1895, to November, 1901.

(c)—For flood studies only.

(d)—Discontinued December, 1904.

(e)—Discontinued December, 1908. No records for this station are published here.

(f)—Discontinued May, 1909. No records for this station are published here.

STREAM-FLOW DATA.

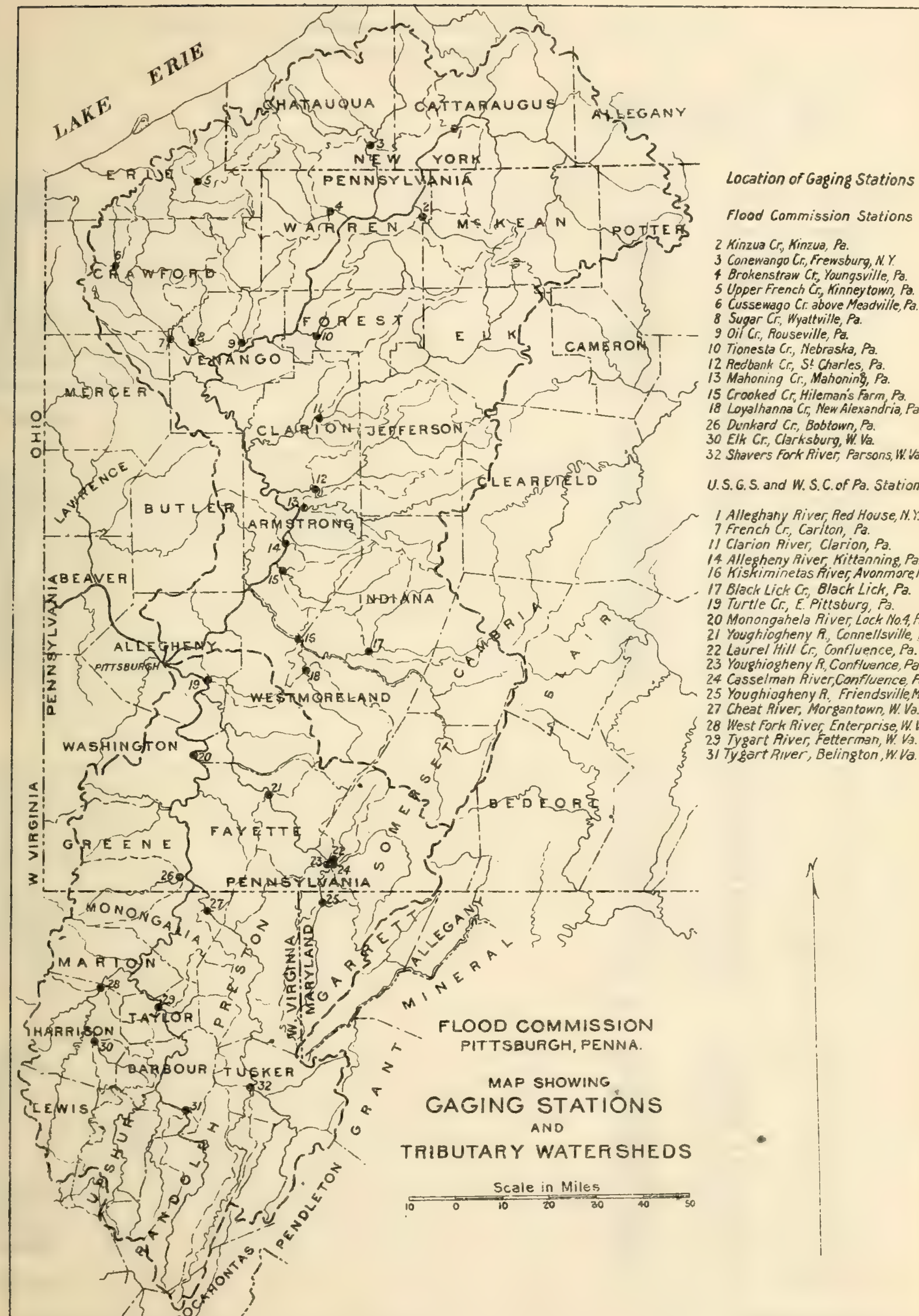
The following pages contain descriptions of the various gaging stations, and also, for each station, a list of discharge measurements, a discharge curve and rating table (except in a few cases where a sufficient number of discharge measurements is not yet available), tables of daily gage heights and discharges, and tables of monthly discharges.

The Flood Commission is indebted for certain of these data to the U. S. Geological Survey, the U. S. Weather Bureau, the Water Supply Commission of Pennsylvania, the State Engineer of New York, the Bureau of Filtration of Pittsburgh and to Mr. F. W. Scheidenhelm. The U. S. Engineer's office at Pittsburgh has also kindly furnished certain miscellaneous discharge measurements and gage heights.

ALLEGHENY BASIN.

ALLEGHENY RIVER AT ASPINWALL, PA.

The following tables of estimated monthly discharge were computed by means of an approximate discharge curve and rating table, based on 23 discharge measurements of the Allegheny River, made by the Bureau of Filtration of Pittsburgh in 1907, 1908 and 1909 at various points near Pittsburgh. The gage heights used in these estimates were taken at Aspinwall and Brilliant, and during the period considered were therefore affected by backwater from Dam No. 2, Allegheny River, then under construction. No figures for maximum and minimum have been given, as discharges for individual days are liable to considerable error on account of these backwater conditions. In the figures for average monthly and annual discharge, however, these errors are largely balanced, and, while they should be used with caution, they may be taken as reasonably approximate. The total drainage area of the Allegheny River, 11,580 square miles, has been used in computing run-off per square mile.



Location of Gaging Stations
Flood Commission Stations
2 Kinzua Cr., Kinzua, Pa.
3 Conewango Cr., Frewsburg, N.Y.
4 Brokenstraw Cr., Youngsville, Pa.
5 Upper French Cr., Kinneytown, Pa.
6 Cussewago Cr. above Meadville, Pa.
8 Sugar Cr., Wyattville, Pa.
9 Oil Cr., Rouseville, Pa.
10 Tionesta Cr., Nebraska, Pa.
12 Redbank Cr., St Charles, Pa.
13 Mahoning Cr., Mahoning, Pa.
15 Crooked Cr., Hileman's Farm, Pa.
18 Loyalhanna Cr., New Alexandria, Pa
26 Dunkard Cr., Bobtown, Pa.
30 Elk Cr., Clarksburg, W. Va.
32 Shavers Fork River, Parsons, W. Va.
U.S.G.S. and W.S.C. of Pa. Stations
1 Alleghany River, Red House, N.Y.
7 French Cr., Carlton, Pa.
11 Clarion River, Clarion, Pa.
14 Allegheny River, Kittanning, Pa.
16 Kiskiminetas River, Avonmore, Pa.
17 Black Lick Cr., Black Lick, Pa.
19 Turtle Cr., E. Pittsburg, Pa.
20 Monongahela River, Lock No. 4, Pa.
21 Youghiogheny R., Connellsville, „
22 Laurel Hill Cr., Confluence, Pa.
23 Youghiogheny R., Confluence, Pa.
24 Casselman River, Confluence, Pa.
25 Youghiogheny R., Friendsville, Md.
27 Cheat River, Morgantown, W. Va.
28 West Fork River, Enterprise, W. Va.
29 Tygart River, Fetterman, W. Va.
31 Tygart River, Belington, W. Va.
FLOOD COMMISSION
PITTSBURGH, PENNA.
MAP SHOWING
GAGING STATIONS
AND
TRIBUTARY WATERSHEDS
Scale in Miles
10 0 10 20 30 40 50
LAKE ERIE
CHATAUQUA
CATTARAUGUS
ALLEGANY
NEW YORK
PENNSYLVANIA
ERIE
WARREN
McKEAN
POTTER
CRAWFORD
FOREST
ELK
CAMERON
VENANGO
MERCER
OHIO
CLARION
JEFFERSON
LAWRENCE
BUTLER
ARMSTRONG
CLEARFIELD
BEAVER
INDIANA
CAMBRIA
BLAIR
ALLEGHENY
PITTSBURGH
WESTMORELAND
WASHINGTON
SOMERSET
BEDFORD
FAYETTE
GREENE
PENNSYLVANIA
W. VIRGINIA
MONONGALIA
PRESTON
W. VIRGINIA
MARYLAND
GARRETT
ALLEGANY
MINERAL
MARION
TAYLOR
HARRISON
BARBOUR
TUCKER
GRANT
LEWIS
UPSHUR
RANDOLPH
PENDLETON
POCAHONTAS

Estimated Monthly Discharge of Allegheny River at Aspinwall, Pa.

[Drainage area, 11580 square miles.] *

Month	Mean discharge second-feet	Run-off: Second-feet per square mile	Run-off: Depth in inches
1903			
January	22300	1.930	2.225
February	53100	4.590	4.780
March	63700	5.500	6.341
April	30600	2.640	2.945
May	9500	0.820	0.945
June	18800	1.620	1.807
July	20100	1.740	2.006
August	21800	1.880	2.167
September	25300	2.180	2.432
October	26000	2.250	2.594
November	21300	1.840	2.053
December	9500	0.820	0.945
The year	26750	2.310	31.240
1904			
January	28400	2.450	2.825
February	24000	2.080	2.243
March	70000	6.050	6.975
April	36200	3.130	3.492
May	28100	2.430	2.802
June	24200	2.090	2.332
July	24200	2.090	2.410
August	20000	1.730	1.994
September	21100	1.820	2.031
October	23700	2.050	2.363
November	20700	1.790	1.997
December	17000	1.470	1.695
The year	28100	2.420	33.159
1905			
January	10000	0.860	0.991
February	3500	0.300	0.312
March	62200	5.380	6.203
April	21400	1.850	2.064
May	10300	0.890	1.026
June	16100	1.390	1.551
July	15600	1.350	1.556
August	16500	1.430	1.649
September	9100	0.790	0.881
October	17800	1.540	1.775
November	19600	1.690	1.886
December	38500	3.320	3.828
The year	20000	1.730	23.722
1906			
January	36400	3.140	3.620
February	9800	0.850	0.885
March	23800	2.060	2.375
April	37800	3.260	3.637
May	14100	1.220	1.407
June	10900	0.940	1.049
July	5800	0.500	0.576
August	17000	1.470	1.695
September	5100	0.440	0.491
October	27200	2.350	2.709
November	36000	3.110	3.470
December	47800	4.130	4.761
The year	22100	1.910	26.675

* Drainage area at mouth.

Estimated Monthly Discharge of Allegheny River at Aspinwall, Pa.—(Continued.)

Month	Mean discharge second-feet	Run-off	
		Second-feet per square mile	Depth in inches
1907			
January	55400	4.780	5.511
February	8620	0.750	0.781
March	56900	4.910	5.661
April	20800	1.800	2.008
May	24600	2.120	2.444
June	21000	1.810	2.019
July	9700	0.840	0.968
August	5000	0.430	0.496
September	6500	0.560	0.625
October	13400	1.160	1.337
November	19100	1.650	1.841
December	27100	2.340	2.698
The year	22800	1.970	26.389
1908			
January	23500	2.030	2.340
February	35300	3.050	3.289
March	71000	6.140	7.079
April	32300	2.790	3.113
May	41400	3.570	4.116
June	10800	0.930	1.038

ALLEGHENY RIVER AT KITTANNING, PA.

This station, which is located at the Market Street bridge, a five-span, steel highway bridge, 45 miles above the mouth, was established August 18, 1904, by R. J. Taylor, of the U. S. Geological Survey. In 1907 the station was taken over by the Water Supply Commission of Pennsylvania.

A standard chain gage, 38.62 feet from marker to bottom of weight, is bolted to the upstream handrail in the first span from the left bank. The west corner of the top course of left abutment is 33.83 feet above zero of the gage. The initial point for soundings is at the left end of handrail, on downstream side of bridge.

The channel is straight for 500 feet above and 100 feet below the station. The banks are high and do not overflow. The bed is composed of gravel and is permanent. The deepest part of the river is at the right hand channel.

There is a marked difference between the discharge at a given high gage height for rising and falling stage, due to increase and decrease of slope. This difference in some cases amounts to as much as 15 per cent. The extreme range of gage heights is from 29.3 feet, in 1865, to 1.3 feet, in September, 1909.

The gage is read daily by S. B. Cochrane.

The drainage area above the station is 9,010 square miles.

Discharge Measurements of Allegheny River at Kittanning, Pa.

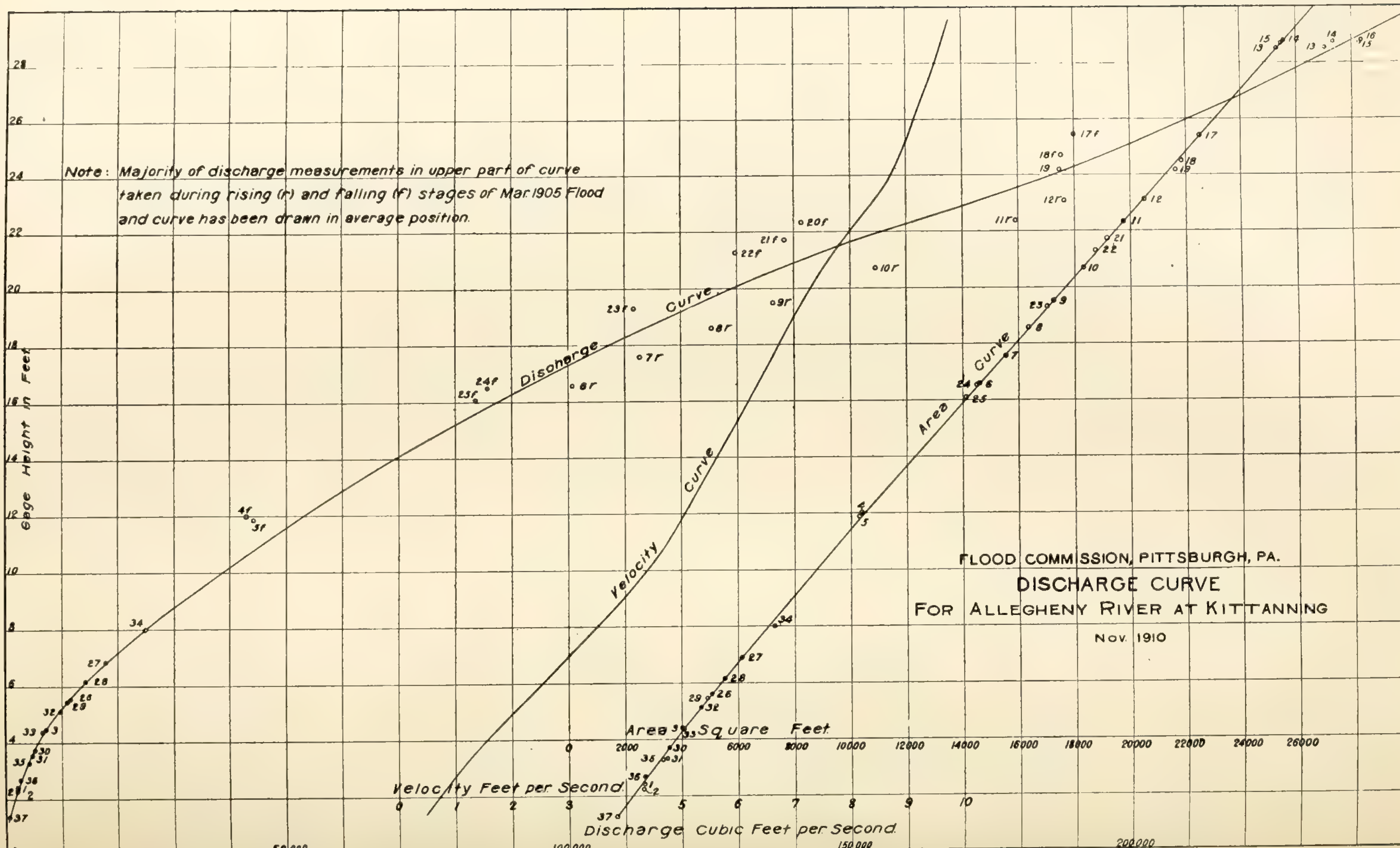
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1904			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Aug.	18	R. J. Taylor	620	2615	0.82	2.40	2140
Sept.	19	E. C. Murphy	603	2602	0.79	2.26	2046
Sept.	29	N. C. Grover	720	4010	1.77	4.42	7087
1905							
Mar.	18	Grover and Morse	869	10480	4.11	12.00	43090
Mar.	18	do	869	10340	4.27	11.85	44150

Discharge Measurements of Allegheny River at Kittanning, Pa.—(Continued.)

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
		Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Mar. 19	N. C. Grover	869	14570	6.92	16.55	100800
Mar. 19	Grover and Morse	869	15500	7.27	17.59	112700
Mar. 19	do	869	16380	7.66	18.57	125500
Mar. 19	do	869	17210	7.93	19.48	136400
Mar. 19	do	869	18270	8.41	20.66	154600
Mar. 19	do	869	19770	9.08	22.33	179500
Mar. 19	do	869	20450	9.20	23.08	188100
Mar. 20	do	869	25330	9.29	28.50	235300
Mar. 20	do	869	25470	9.30	28.69	236900
Mar. 20	do	869	25510	9.48	28.71	241800
Mar. 20	do	869	25540	9.48	28.74	242000
Mar. 21	do	869	22540	8.43	25.40	190000
Mar. 21	do	869	21860	8.13	24.65	177800
Mar. 21	do	869	21440	8.28	24.18	177500
Mar. 22	do	869	19740	7.16	22.29	141400
Mar. 22	do	869	19200	7.20	21.69	138400
Mar. 22	do	869	18790	6.91	21.24	129800
Mar. 23	do	869	17000	6.57	19.25	111700
Mar. 24	do	869	14510	5.92	16.48	85960
Mar. 25	do	869	14110	5.94	16.04	83840
Apr. 10	A. H. Horton	809	5000	2.37	5.54	11860
Apr. 11	do	860	6106	2.94	6.83	17970
Apr. 14	do	835	5552	2.58	6.17	14320
Apr. 20	do	791	4919	2.24	5.45	11040
June 2	R. H. Bolster	680	3597	1.45	3.73	5222
Aug. 30	E. C. Murphy	666	3442	1.39	3.53	4794
Nov. 3	do	768	4654	2.13	5.10	9941
1906						
May 23	Robert Follansbee	719	4030	1.66	4.40	6700
1907						
May 30	A. H. Horton	861	7270	3.48	8.00	25300
Sept. 11	do	648	3320	1.25	3.24	4150
1908						
Aug. 23	R. H. Bolster	613	2710	0.99	2.67	2690
Sept. 25	C. E. Ryder	466	1710	0.49	1.37	847

Rating Table for Allegheny River at Kittanning, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.30	775	4.10	6105	6.90	18410	9.70	36500	12.50	56840
.40	880	.20	6380	7.00	19000	.80	37200	.60	57630
.50	990	.30	6660	.10	19590	.90	37900	.70	58420
.60	1100	.40	6955	.20	20190	10.00	38600	.80	59210
.70	1220	.50	7260	.30	20790	.10	39310	.90	60000
.80	1340	.60	7600	.40	21400	.20	40020	13.00	60800
.90	1465	.70	7985	.50	22025	.30	40730	.10	61600
2.00	1605	.80	8375	.60	22650	.40	41440	.20	62410
.10	1755	.90	8775	.70	23275	.50	42150	.30	63220
.20	1920	5.00	9200	.80	23900	.60	42860	.40	64040
.30	2085	.10	9635	.90	24525	.70	43570	.50	64870
.40	2260	.20	10080	8.00	25150	.80	44280	.60	65700
.50	2445	.30	10525	.10	25800	.90	44990	.70	66540
.60	2640	.40	10980	.20	26450	11.00	45700	.80	67390
.70	2850	.50	11440	.30	27100	.10	46420	.90	68240
.80	3060	.60	11900	.40	27750	.20	47140	14.00	69100
.90	3270	.70	12370	.50	28400	.30	47860	.10	69970
3.00	3490	.80	12840	.60	29050	.40	48590	.20	70840
.10	3715	.90	13315	.70	29700	.50	49320	.30	71720
.20	3940	6.00	13800	.80	30350	.60	50050	.40	72600
.30	4165	.10	14285	.90	31025	.70	50780	.50	73490
.40	4390	.20	14770	9.00	31700	.80	51520	.60	74380
.50	4620	.30	15260	.10	32375	.90	52760	.70	75270
.60	4850	.40	15755	.20	33050	12.00	53000	.80	76170
.70	5080	.50	16250	.30	33725	.10	53750	.90	77080
.80	5335	.60	16760	.40	34400	.20	54510	15.00	78000
.90	5580	.70	17290	.50	35100	.30	55280	.10	78930
4.00	5840	.80	17840	.60	35800	.40	56060	.20	79870



Note: Majority of discharge measurements in upper part of curve taken during rising (r) and falling (f) stages of Mar. 1905 Flood and curve has been drawn in average position.
Gage Height in Feet
Discharge Curve
Velocity Curve
Area Curve
Area Square Feet
Velocity Feet per Second
Discharge Cubic Feet per Second
FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR ALLEGHENY RIVER AT KITTANNING
NOV. 1910

Rating Table for Allegheny River at Kittanning, Pa.—(Continued.)

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
15.30	80810	18.10	108390	20.90	140420	23.70	182290	26.40	215550
.40	81750	.20	109440	21.00	141750	.80	183650	.50	216670
.50	82700	.30	110490	.10	143090	.90	184990	.60	217780
.60	83650	.40	111540	.20	144450	24.00	186300	.70	218880
.70	84600	.50	112600	.30	145830	.10	187610	.80	219965
.80	85550	.60	113660	.40	147230	.20	188910	.90	221040
.90	86500	.70	114730	.50	148650	.30	190210	27.00	222100
16.00	87450	.80	115810	.60	150090	.40	191500	.10	223145
.10	88400	.90	116900	.70	151550	.50	192790	.20	224175
.20	89360	19.00	118000	.80	153030	.60	194070	.30	225190
.30	90320	.10	119100	.90	154530	.70	195350	.40	226200
.40	91280	.20	120200	22.00	156050	.80	196620	.50	227210
.50	92240	.30	121310	.10	157590	.90	197890	.60	228220
.60	93200	.40	122420	.20	159150	25.00	199150	.70	229230
.70	94160	.50	123540	.30	160730	.10	200390	.80	230240
.80	95130	.60	124670	.40	162330	.20	201610	.90	231245
.90	96110	.70	125800	.50	163945	.30	202810	28.00	232250
17.00	97100	.80	126940	.60	165560	.40	204000	.10	233245
.10	98100	.90	128090	.70	167175	.50	205180	.20	234240
.20	99110	20.00	129250	.80	168790	.60	206360	.30	235235
.30	100130	.10	130420	.90	170400	.70	207535	.40	236230
.40	101150	.20	131610	23.00	172000	.80	208700	.50	237225
.50	102170	.30	132820	.10	173570	.90	209850	.60	238220
.60	103200	.40	134050	.20	175110	26.00	211000	.70	239215
.70	104230	.50	135290	.30	176610	.10	212145	.80	240210
.80	105270	.60	136550	.40	178070	.20	213285	.90	241205
.90	106310	.70	137820	.50	179500	.30	214420	29.00	242200
18.00	107350	.80	139110	.60	180910				

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1904.

Day	August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.	----	----	2.90	3270	3.80	5335	3.80	5335	2.30	2085
2.	----	----	2.80	3060	4.00	5840	3.60	4850	2.60	2640
3.	----	----	2.80	3060	4.00	5840	3.40	4390	2.70	2850
4.	----	----	2.70	2850	3.80	5335	3.30	4165	2.80	3060
5.	----	----	2.80	3060	3.80	5335	3.10	3715	2.70	2850
6.	----	----	3.50	4620	3.40	4390	3.10	3715	2.50	2445
7.	----	----	3.30	4165	3.40	4390	3.20	3940	2.50	2445
8.	----	----	3.00	3490	3.10	3715	3.00	3490	2.60	2640
9.	----	----	2.70	2850	3.00	3490	2.80	3060	2.50	2445
10.	----	----	2.70	2850	2.80	3060	2.80	3060	2.30	2085
11.	----	----	2.80	3060	2.60	2640	2.80	3060	2.70	2850
12.	----	----	2.70	2850	3.40	4390	2.80	3060	b2.80	3060
13.	----	----	2.60	2640	3.60	4850	2.80	3060	2.80	3060
14.	----	----	2.40	2260	4.30	6660	2.70	2850	2.90	3270
15.	----	----	2.30	2085	4.40	6955	a2.70	2850	2.90	3270
16.	----	----	2.20	1920	4.10	6105	a2.70	2850	2.90	3270
17.	----	----	2.20	1920	4.00	5840	a2.60	2640	2.90	3270
18.	----	----	2.40	2260	3.70	5080	a2.60	2640	3.00	3490
19.	----	----	2.20	1920	3.50	4620	a2.50	2445	3.30	4165
20.	----	----	2.20	1920	3.30	4165	2.50	2445	3.20	3940
21.	----	----	2.10	1755	3.20	3940	2.40	2260	3.00	3490
22.	----	----	2.00	1605	3.30	4165	2.40	2260	2.90	3270
23.	----	----	2.00	1605	3.30	4165	2.40	2260	2.90	3270
24.	----	----	2.00	1605	4.30	6660	2.30	2085	3.40	4390
25.	4.50	7260	2.00	1605	5.70	12370	2.40	2260	8.30	27100
26.	3.90	5580	2.00	1605	6.00	13800	2.40	2260	7.30	20790
27.	3.90	5580	3.40	4390	5.70	12370	2.40	2260	8.00	25150
28.	4.10	6105	4.60	7600	5.10	9635	2.30	2085	11.90	52260
29.	3.70	5080	4.50	7260	4.70	7985	2.30	2085	12.40	56060
30.	3.40	4390	4.10	6105	4.40	6955	2.30	2085	10.60	42860
31.	3.10	3715	----	----	4.10	6105	----	----	8.80	30350

a. Gage height interpolated. Gage out of order, river stationary Nov. 15 to 19 inclusive.
b. Readings to top of ice Dec. 12–31.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1905.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	8.10	25800	9.80	37200	.....	.....	10.50	40400	5.30	10535	3.80	5335
2	7.40	21400	9.60	35800	.....	.....	8.90	30500	4.90	8775	3.70	5080
3	7.90	24525	9.60	35800	9.40	34400	7.70	23275	4.80	8375	3.60	4850
4	8.50	28400	9.60	35800	.....	.....	7.30	20790	4.50	7260	3.40	4390
5	7.40	21400	....	.....	.....	.....	7.00	19000	4.20	6380	3.30	4165
6	6.30	15260	....	.....	.....	.....	6.80	17840	....	.....	3.60	4850
7	6.10	14285	9.50	35100	.....	.....	6.40	15755	....	.....	4.30	6660
8	6.20	14770	....	.....	11.60	50050	5.90	13315	....	.....	7.00	19000
9	6.30	15260	....	.....	.....	.....	5.60	11900	....	.....	6.80	17840
10	6.40	15755	9.00	31700	.....	.....	5.50	11440	5.50	11440	6.30	15260
11	6.60	16760	....	.....	.....	.....	6.40	15755	5.00	9200	5.90	13315
12	10.40	41440	....	.....	.....	.....	6.20	14770	4.70	7985	5.60	11900
13	12.30	55280	....	.....	.....	.....	6.20	14770	5.50	11440	5.20	10080
14	13.60	65700	9.00	31700	.....	.....	5.80	12840	6.50	16250	5.20	10080
15	15.40	81750	....	.....	.....	.....	5.50	11440	6.90	18410	4.70	7985
16	16.10	88400	....	.....	.....	.....	5.40	10980	7.10	19590	4.50	7260
17	16.10	88400	8.70	29700	.....	.....	5.30	10535	7.20	20190	4.50	7260
18	14.60	74380	....	.....	13.00	64500	5.30	10535	6.70	17290	5.00	9200
19	14.40	72600	....	.....	18.20	120000	5.10	9635	6.30	15260	6.10	14285
20	14.40	72600	....	.....	a 28.20	235500	5.30	10535	5.60	11900	7.40	21400
21	14.40	72600	8.40	27750	24.80	183500	6.90	18410	5.10	9635	8.30	27100
22	13.80	67390	....	.....	21.80	137800	9.20	33050	4.70	7985	10.00	38600
23	13.10	61600	....	.....	18.40	103700	10.60	42860	4.50	7260	9.60	35800
24	12.30	55280	8.10	25800	16.50	86500	9.40	34400	4.20	6380	9.30	33725
25	11.40	48590	....	.....	16.00	82000	8.80	30350	4.00	5840	7.80	23900
26	10.60	42860	....	.....	15.80	80500	7.20	20190	3.90	5580	6.70	17290
27	10.10	39310	....	.....	15.00	73400	6.80	17840	4.20	6380	6.40	15755
28	10.00	38600	9.10	32375	14.30	67300	6.20	14770	4.20	6380	5.70	12370
29	9.90	37900	....	.....	13.70	62600	5.90	13315	4.40	6955	5.00	9200
30	9.90	37900	....	.....	12.60	54400	5.60	11900	4.40	6955	4.60	7600
31	9.80	37200	....	.....	11.80	48750	....	.....	4.20	6380	....	.....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.40	6955	7.65	22960	3.10	3715	3.30	4165	4.70	7985	12.80	59210
2	4.80	8375	6.30	15260	3.10	3715	3.40	4390	4.60	7600	10.80	44280
3	5.10	9635	5.30	10535	3.10	3715	3.60	4850	4.50	7260	14.90	77080
4	5.40	10980	4.70	7985	3.10	3715	5.00	9200	5.00	9200	14.80	76170
5	6.80	17840	4.30	6660	2.80	3060	4.30	6660	5.10	9635	12.20	54510
6	6.60	16760	3.90	5580	2.80	3060	3.80	5335	5.30	10535	10.70	43570
7	7.00	19000	3.80	5335	2.80	3060	3.60	4850	6.20	14770	9.00	31700
8	9.20	33050	3.80	5335	2.60	2640	3.20	3940	7.00	19000	8.20	26450
9	7.70	23275	3.80	5335	2.50	2445	2.80	3060	8.00	25150	7.70	23275
10	7.40	21400	3.90	5580	2.50	2445	2.80	3060	7.60	22650	7.30	20790
11	5.90	13315	4.00	5840	4.85	8575	3.00	3490	7.40	21400	7.00	19000
12	6.00	13800	3.60	4850	7.40	21400	4.10	6105	6.80	17840	6.60	16760
13	7.30	20790	5.40	10980	6.80	17840	5.50	11440	6.60	16760	6.40	15755
14	8.10	25800	6.20	14770	5.50	11440	5.30	10535	6.50	16250	6.00	13800
15	8.60	29050	5.80	12840	5.00	9200	5.50	11440	6.30	15260	5.80	12840
16	8.10	25800	6.00	13800	4.70	7985	5.40	10980	6.10	14285	5.20	10080
17	7.60	22650	6.50	16250	4.50	7260	5.25	10300	5.90	13315	4.70	7985
18	7.00	19000	5.60	11900	4.50	7260	4.80	8375	5.80	12840	4.50	7260
19	6.40	15755	4.80	8375	4.50	7260	5.60	11900	5.60	11900	4.40	6955
20	6.10	14285	4.20	6380	4.60	7600	6.20	14770	5.50	11440	4.30	6660
21	5.80	12840	4.20	6380	4.50	7260	9.50	35100	5.20	10080	5.60	11900
22	5.40	10980	4.50	7260	4.40	6955	8.20	26450	4.80	8375	7.80	23900
23	4.20	6380	4.80	8375	4.10	6105	7.40	21400	4.70	7985	9.70	36500
24	3.80	5335	5.20	10080	3.70	5080	7.30	20790	4.60	7600	9.60	35800
25	3.60	4850	4.80	8375	3.50	4620	7.30	20790	4.60	7600	8.10	25800
26	3.50	4620	4.60	7600	3.20	3940	6.70	17290	4.50	7260	7.20	20190
27	3.40	4390	4.20	6380	3.10	3715	6.30	15260	4.80	8375	6.90	18410
28	3.30	4165	3.80	5335	3.10	3715	5.80	12840	6.00	13800	8.90	31025
29	3.10	3715	3.60	4850	3.10	3715	5.30	10535	9.20	33050	9.90	37900
30	11.40	48590	3.40	4390	3.20	3940	5.10	9635	12.00	53000	11.20	47140
31	10.60	42860	3.20	3940	....	....	4.90	8775	.....	.....	11.30	47860

River frozen Jan. 12 to Mar. 18. Ice gorge Jan. 12 to Feb. 12 approximately. a. Max. 28.80 = 240210 sec.-ft.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1906.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	9.70	36500	6.30	15260	4.50	7260	13.20	62410	4.70	7985	4.80	8375	2.50	2445	2.20	1920	2.60	2640	2.50	2445	7.70	23275	5.60	11900
2	8.80	30350	5.80	12840	4.80	8375	11.80	51520	4.80	8375	4.60	7600	2.30	2085	2.30	2085	3.10	3715	3.80	5335	7.40	21400	5.20	10080
3	8.90	31025	5.10	9635	5.50	11440	10.00	38600	4.80	8375	4.50	7260	2.30	2085	2.10	1755	3.50	4620	4.10	6105	7.60	22650	5.10	9635
4	9.10	32375	4.40	6955	5.90	13315	9.40	34400	6.30	15260	a4.20	6380	2.40	2260	2.10	1755	3.40	4390	4.20	6380	6.20	14770	5.00	9200
5	10.20	40020	4.50	7260	6.20	14770	8.60	29050	6.70	17290	3.90	5580	2.40	2260	2.00	1605	3.50	4620	3.80	5335	5.80	12840	5.30	10535
6	9.80	37200	4.40	6955	6.90	18410	9.50	35100	6.70	17290	3.70	5080	2.40	2260	2.00	1605	3.60	4850	3.20	3940	5.60	11900	5.80	12840
7	8.60	29050	4.30	6660	6.20	14770	10.20	40020	7.10	19590	9.30	33725	2.40	2260	2.10	1755	3.20	3940	3.40	4390	5.40	10980	13.80	67390
8	7.30	20790	4.20	6380	5.90	13315	9.50	35100	5.60	11900	7.35	21095	2.40	2260	3.70	5080	2.90	3270	6.00	13800	5.10	9635	13.00	60800
9	6.70	17290	4.10	6105	5.70	12370	8.80	30350	5.70	12370	5.60	11900	2.40	2260	4.90	8775	2.60	2640	7.20	20190	4.80	8375	11.60	50050
10	5.40	10980	4.00	5840	5.50	11440	11.20	47140	5.60	11900	5.10	9635	2.30	2085	4.10	6105	2.40	2260	6.90	18410	4.60	7600	7.90	24525
11	6.00	13800	3.90	5580	5.40	10980	13.20	62410	5.40	10980	4.70	7985	2.30	2085	5.50	11440	2.20	1920	6.90	18410	4.50	7260	10.50	42150
12	5.70	12370	3.90	5580	5.30	10535	12.20	54510	5.40	10980	4.10	6105	2.30	2085	5.20	10080	2.40	2260	7.20	20190	4.50	7260	11.50	49320
13	6.40	15755	3.90	5580	5.10	9635	10.30	40730	5.40	10980	3.80	5335	2.20	1920	4.80	8375	2.50	2445	6.90	18410	4.60	7600	10.10	39310
14	5.70	12370	4.00	5840	4.80	8375	9.50	35100	5.30	10535	3.60	4850	2.10	1755	3.90	5580	2.40	2260	6.80	17840	5.10	9635	8.90	31025
15	5.70	12370	4.00	5840	4.70	7985	9.90	37900	5.40	10980	3.30	4165	2.00	1605	3.50	4620	2.90	3270	6.80	17840	5.20	10080	8.30	27100
16	5.50	11440	4.10	6105	4.60	7600	9.70	36500	5.40	10980	3.10	3715	1.90	1465	3.20	3940	2.30	2085	6.90	18410	5.20	10080	12.00	53000
17	6.10	14285	4.10	6105	4.40	6955	9.30	33725	5.30	10535	3.00	3490	2.20	1920	2.90	3270	2.10	1755	6.10	14285	5.10	9635	11.90	52260
18	7.30	20790	4.10	6105	4.30	6660	8.80	30350	5.40	10980	3.30	4165	2.40	2260	2.50	2445	2.10	1755	6.70	17290	5.40	10980	11.90	52260
19	7.70	23275	4.10	6105	4.10	6105	7.90	24525	5.30	10535	3.20	3940	2.40	2260	8.00	25150	2.00	1605	5.10	9635	8.60	29050	9.20	33050
20	7.50	22025	4.10	6105	3.80	5335	7.20	20190	5.30	10535	3.20	3940	2.40	2260	7.00	19000	2.40	2260	5.70	12370	9.40	34400	8.20	26450
21	8.00	25150	4.20	6380	4.00	5840	6.90	18410	a5.00	9200	3.30	4165	2.20	1920	5.20	10080	2.70	2850	5.80	12840	9.80	37200	7.20	20190
22	9.65	36150	4.40	6955	4.10	6105	6.50	16250	a4.70	7985	3.40	4390	2.10	1755	4.80	8375	3.00	3490	6.10	14285	10.10	39310	6.80	17840
23	12.20	54510	4.60	7600	4.00	5840	6.30	15260	4.40	6955	3.30	4165	2.40	2260	4.20	6380	3.00	3490	6.70	17290	9.50	35100	6.30	15260
24	13.00	60800	4.70	7985	4.00	5840	6.00	13800	a4.25	6520	3.10	3715	2.50	2445	4.80	8375	2.80	3060	5.20	10080	8.60	29050	5.60	11900
25	12.30	55280	5.40	10980	3.90	5580	5.70	12370	4.10	6105	2.90	3270	2.30	2085	4.20	6380	2.80	3060	5.00	9200	7.50	22025	5.70	12370
26	11.20	47140	5.80	12840	4.10	6105	5.60	11900	4.00	5840	2.90	3270	2.00	1605	3.80	5335	2.90	3270	5.80	12840	6.80	17840	5.10	9635
27	9.60	35800	5.20	10080	6.60	16760	5.40	10980	4.60	7600	2.80	3060	1.90	1465	3.60	4850	2.30	2085	6.80	17840	6.30	15260	5.30	10535
28	8.30	27100	4.90	8775	13.80	67390	5.50	11440	4.70	7985	2.70	2850	2.30	2085	3.30	4165	2.40	2260	6.80	17840	6.00	13800	6.50	16250
29	7.50	22025	....	.....	14.00	69100	5.30	10535	4.80	8375	2.80	3060	2.20	1920	3.10	3715	2.50	2445	6.90	18410	5.20	10080	5.90	13315
30	6.00	13800	....	.....	12.60	57630	4.90	8775	4.90	8775	2.70	2850	2.20	1920	2.90	3270	2.50	2445	7.50	22025	5.70	12370	5.50	11440
31	6.50	16250	....	.....	13.60	65700	....	.....	5.00	9200	....	....	2.10	1755	2.70	2850	....	....	7.90	24525	....	.....	7.40	21400

a. Interpolated.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1907.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	8.40	27750	5.10	9635	4.20	6380	9.40	34400	8.00	25150	5.90	13315
2	10.50	42150	5.20	10080	4.60	7600	8.30	27100	7.50	22025	6.00	13800
3	9.60	35800	5.40	10980	5.80	12840	7.60	22650	7.20	20190	7.50	22025
4	9.50	35100	5.60	11900	6.00	13800	6.90	18410	7.80	23900	8.30	27100
5	12.90	60000	5.00	9200	6.10	14285	6.70	17290	8.50	28400	7.90	24525
6	12.40	56060	5.10	9635	6.80	17840	6.70	17290	9.00	31700	8.80	30350
7	11.20	47140	4.80	8375	5.60	11900	6.60	16760	8.70	29700	9.90	37900
8	10.90	44990	4.50	7260	5.20	10080	6.40	15755	8.00	25150	9.30	33725
9	13.70	66540	4.30	6660	4.80	8375	6.20	14770	8.60	29050	8.00	25150
10	12.80	59210	4.40	6955	4.70	7985	6.30	15260	8.10	25800	6.90	18410
11	11.30	47860	4.70	7985	4.60	7600	6.10	14285	7.30	20790	6.30	15260
12	10.30	40730	4.50	7260	4.70	7985	5.90	13315	6.80	17840	7.00	19000
13	10.00	38600	4.80	8375	8.60	29050	5.90	13315	6.30	15260	6.40	15755
14	9.70	36500	4.30	6660	14.00	69100	5.60	11900	6.20	14770	7.90	24525
15	10.90	44990	4.20	6380	15.90	86500	6.20	14770	5.60	11900	7.50	22025
16	10.10	39310	5.00	9200	14.20	70840	5.90	13315	5.90	13315	6.60	16760
17	9.20	33050	4.50	7260	13.00	60800	5.70	12370	7.30	20790	5.80	12840
18	8.10	25800	4.60	7600	13.10	61600	5.60	11900	7.20	20190	5.30	10535
19	9.40	34400	4.60	7600	12.70	58420	5.50	11440	6.60	16760	4.80	8375
20	13.50	64870	5.10	9635	13.80	67390	5.30	10535	6.40	15755	4.60	7600
21	13.60	65700	5.50	11440	13.30	63220	5.20	10080	7.20	20190	4.50	7260
22	12.70	58420	5.50	11440	11.80	51520	5.00	9200	6.80	17840	4.60	7600
23	10.30	40730	5.60	11900	10.60	42860	4.80	8375	6.30	15260	4.80	8375
24	8.10	25800	5.00	9200	10.80	44280	6.20	14770	5.90	13315	4.60	7600
25	7.00	19000	4.60	7600	10.30	40730	9.50	35100	5.60	11900	5.00	9200
26	6.50	16250	4.00	5840	9.40	34400	9.90	37900	5.40	10980	5.60	11900
27	6.70	17290	4.40	6955	10.40	41440	12.00	53000	5.90	13315	5.40	10980
28	5.90	13315	4.20	6380	12.80	59210	10.90	44990	10.00	38600	5.30	10535
29	5.60	11900	....	....	13.50	64870	9.60	35800	9.10	32375	4.80	8375
30	5.60	11900	....	....	12.50	56840	8.50	28400	7.70	23275	4.60	7600
31	5.30	10535	....	....	10.80	44280	.....	.....	6.60	16760	....	.....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.70	7985	2.80	3060	1.70	1220	3.20	3940	5.20	10080	4.10	6105
2	6.90	18410	2.80	3060	1.90	1465	3.20	3940	4.90	8775	4.80	8375
3	7.00	19000	4.60	7600	2.40	2260	3.20	3940	6.10	14285	4.60	7600
4	6.30	15260	4.00	5840	2.00	1605	4.20	6380	9.80	37200	4.10	6105
5	5.60	11900	2.40	2260	2.20	1920	7.35	21095	9.30	33725	4.20	6380
6	5.20	10080	3.20	3940	2.00	1605	6.60	16760	9.30	33725	4.00	5840
7	4.60	7600	2.80	3060	1.90	1465	6.70	17290	8.90	31025	3.90	5580
8	4.40	6955	2.70	2850	1.80	1340	6.80	17840	8.20	26450	3.70	5080
9	4.00	5840	2.60	2640	2.00	1605	5.80	12840	8.60	29050	4.60	7600
10	3.80	5335	2.40	2260	2.00	1605	6.90	18410	8.40	27750	5.20	10080
11	3.70	5080	2.30	2085	3.00	3490	6.90	18410	8.30	27100	6.00	13800
12	3.70	5080	2.30	2085	4.00	5840	5.50	11440	8.10	25800	7.10	19590
13	3.80	5335	2.00	1605	3.80	5335	5.00	9200	7.80	23900	8.00	25150
14	6.00	13800	2.10	1755	3.50	4620	5.60	11900	7.60	22650	6.60	16760
15	5.30	10535	1.80	1340	2.90	3270	6.20	14770	7.50	22025	6.40	15755
16	4.50	7260	1.80	1340	2.70	2850	5.90	13315	7.40	21400	6.10	14285
17	3.90	5580	2.00	1605	2.70	2850	5.30	10535	7.00	19000	6.10	14285
18	4.40	6955	1.80	1340	3.30	4165	4.70	7985	6.60	16760	6.00	13800
19	4.30	6660	1.90	1465	3.90	5580	4.20	6380	6.20	14770	5.90	13315
20	3.90	5580	1.80	1340	3.60	4850	3.90	5580	5.80	12840	5.80	12840
21	3.50	4620	1.70	1220	3.50	4620	3.60	4850	5.40	10980	4.50	7260
22	3.00	3490	1.70	1220	3.60	4850	3.70	5080	5.10	9635	4.70	7985
23	3.00	3490	1.80	1340	3.40	4390	3.80	5335	4.70	7985	5.70	12370
24	3.00	3490	1.80	1340	3.10	3715	3.70	5080	4.50	7260	15.00	78000
25	3.20	3940	1.70	1220	2.80	3060	3.70	5080	4.40	6955	15.30	80810
26	3.10	3715	1.90	1465	2.50	2445	3.50	4620	4.20	6380	13.20	62410
27	4.20	6380	1.90	1465	2.30	2085	3.40	4390	4.10	6105	11.60	50050
28	3.70	5080	1.80	1340	2.30	2085	4.40	6955	4.30	6660	10.20	40020
29	3.40	4390	1.50	990	2.80	3060	5.90	13315	4.50	7260	11.40	48590
30	3.30	4165	1.80	1340	3.30	4165	6.40	15755	4.90	8775	11.20	47140
31	3.00	3490	1.60	1100	....	....	5.90	13315	....	.....	11.10	46420

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1908.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	10.40	41440	6.90	18410	5.40	10980	10.90	44990	7.40	21400	8.30	27100	3.70	5080	3.50	4620	1.77	1305	1.57	1065	1.57	1065	1.77	1305
2	9.80	37200	8.20	26450	12.50	56840	9.00	31700	8.40	27750	7.90	24525	3.60	4850	3.20	3940	1.67	1185	1.67	1185	1.57	1065	1.77	1305
3	8.40	27750	8.20	26450	14.70	75270	8.60	29050	10.20	40020	7.10	19590	3.90	5580	3.00	3490	1.57	1065	1.67	1185	1.57	1065	1.87	1430
4	7.60	22650	8.20	26450	12.10	53750	8.20	26450	10.80	44280	6.60	16760	3.70	5080	3.00	3490	1.57	1065	1.67	1185	1.47	955	1.87	1430
5	7.10	19590	8.20	26450	11.40	48590	7.80	23900	11.00	45700	6.00	13800	6.90	18410	2.80	3060	1.47	955	1.57	1065	1.47	955	1.87	1430
6	6.80	17840	8.30	27100	12.90	60000	7.30	20790	11.00	45700	5.30	10535	5.00	9200	2.60	2640	1.37	850	1.57	1065	1.37	850	1.87	1430
7	6.20	14770	8.30	27100	16.40	91280	7.60	22650	11.20	47140	5.20	10080	4.50	7260	3.00	3490	1.47	955	1.57	1065	1.37	850	1.87	1430
8	5.30	10535	8.20	26450	14.90	77080	8.60	29050	13.10	61600	5.00	9200	4.20	6380	3.30	4165	1.57	1065	1.47	955	1.37	850	1.87	1430
9	5.30	10535	8.10	25800	13.50	64870	9.60	35800	12.60	57630	4.90	8775	3.80	5335	3.30	4165	1.67	1185	1.47	955	1.47	955	1.87	1430
10	5.20	10080	8.00	25150	11.80	51520	10.20	40020	11.00	45700	5.20	10080	3.30	4165	3.30	4165	1.77	1305	1.47	955	1.47	955	1.87	1430
11	4.10	6105	8.00	25150	9.80	37200	9.60	35800	10.30	40730	4.80	8375	3.40	4390	3.30	4165	1.67	1185	1.47	955	1.57	1065	2.00	1605
12	6.30	15260	a9.00	31700	10.40	41440	8.50	28400	9.30	33725	4.80	8375	3.60	4850	3.00	3490	1.67	1185	1.47	955	1.57	1065	2.00	1605
13	7.20	20190	a10.00	38600	12.90	60000	8.20	26450	8.80	30350	4.60	7600	3.60	4850	2.90	3270	1.57	1065	1.47	955	1.67	1185	2.00	1605
14	10.90	44990	11.00	45700	14.50	73490	8.00	25150	7.90	24525	4.60	7600	3.50	4620	2.60	2640	1.57	1065	1.47	955	1.77	1305	2.10	1755
15	9.60	35800	18.90	116900	15.40	81750	8.10	25800	7.10	19590	4.40	6955	3.70	5080	2.20	1920	1.47	955	1.37	850	1.67	1185	2.10	1755
16	8.50	28400	24.30	190210	16.80	95130	8.40	27750	8.50	28400	4.20	6380	3.70	5080	2.10	1755	1.47	955	1.47	955	1.57	1065	2.20	1920
17	7.50	22025	18.70	114730	16.50	92240	8.20	26450	12.10	53750	4.20	6380	4.60	7600	2.00	1605	1.47	955	1.47	955	1.67	1185	2.40	2260
18	6.80	17840	15.40	81750	16.90	96110	8.00	25150	10.55	42505	4.00	5840	5.20	10080	2.00	1605	1.47	955	1.47	955	1.67	1185	4.90	8775
19	6.40	15755	12.80	59210	18.70	114730	8.60	29050	10.60	42860	3.80	5335	5.30	10535	2.30	2085	1.47	955	1.47	955	1.67	1185	6.40	15755
20	6.00	13800	10.90	44990	17.60	103200	9.90	37900	12.10	53750	3.60	4850	5.40	10980	2.60	2640	1.37	850	1.47	955	1.67	1185	6.50	16250
21	5.80	12840	9.80	37200	13.90	68240	10.40	41440	11.20	47140	3.40	4390	5.20	10080	2.70	2850	1.37	850	1.37	850	1.77	1305	5.00	9200
22	5.60	11900	8.30	27100	11.20	47140	9.10	32375	10.10	39310	3.50	4620	4.90	8775	3.10	3715	1.37	850	1.37	850	1.77	1305	4.10	6105
23	6.00	13800	7.50	22025	10.40	41440	8.50	28400	9.60	35890	3.80	5335	6.80	17840	2.70	2850	1.37	850	1.37	850	1.77	1305	3.60	4850
24	6.30	15260	6.70	17290	9.30	33725	8.00	25150	8.30	27100	4.20	6380	8.10	25800	2.30	2085	1.37	850	1.37	850	1.87	1430	3.20	3940
25	6.10	14285	6.30	15260	9.10	32375	7.80	23900	7.60	22650	4.80	8375	7.90	24525	2.20	1920	1.37	850	1.37	850	1.87	1430	3.80	5335
26	5.80	12840	6.50	16250	8.80	30350	7.10	19590	7.30	20790	5.20	10080	6.10	14285	2.20	1920	1.37	850	1.47	955	1.87	1430	4.10	6105
27	5.60	11900	6.30	15260	8.60	29050	6.60	16760	7.10	19590	4.90	8775	5.50	11440	2.00	1605	1.37	850	1.47	955	1.97	1565	4.00	5840
28	7.70	23275	5.80	12840	9.50	35100	6.40	15755	10.20	40020	4.60	7600	5.00	9200	2.00	1605	1.37	850	1.47	955	1.97	1565	3.90	5580
29	6.80	17840	5.20	10080	10.90	44990	6.90	18410	8.70	29700	4.20	6380	4.80	8375	1.87	1430	1.47	955	1.47	955	1.87	1430	4.10	6105
30	5.90	13315	....	.....	10.90	44990	7.60	22650	9.10	32375	3.90	5580	4.40	6955	1.77	1305	1.57	1065	1.47	955	1.77	1305	4.30	6660
31	5.10	9635	....	.....	10.80	44280	....	.....	8.70	29700	....	....	3.90	5580	1.77	1305	....	....	1.57	1065	....	....	4.70	7985

a. Interpolated.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.90	8775	5.80	12840	9.90	37900	7.50	22025	c22.80	168790	4.60	7600
2	5.20	10080	5.00	9200	9.50	35100	7.20	20190	20.85	139765	4.40	6955
3	6.70	17290	4.20	6380	8.90	31025	7.10	19590	18.15	108915	4.20	6380
4	9.50	35100	4.60	7600	9.40	34400	7.00	19000	16.90	96110	4.00	5840
5	11.40	48590	6.20	14770	8.90	31025	7.00	19000	14.30	71720	4.20	6380
6	13.50	64870	8.30	27100	7.70	23275	7.10	19590	11.70	50780	6.00	13800
7	13.10	61600	10.70	43570	7.30	20790	8.70	29700	10.30	40730	6.50	16250
8	10.30	40730	10.80	44280	7.60	22650	8.60	29050	9.50	35100	7.10	19590
9	8.20	26450	9.70	36500	8.10	25800	8.10	25800	8.00	25150	7.10	19590
10	7.70	23275	8.60	29050	10.30	40730	7.90	24525	7.90	24525	7.20	20190
11	7.30	20790	8.10	25800	11.70	50780	7.60	22650	7.60	22650	7.10	19590
12	6.10	14285	7.70	23275	10.70	43570	7.50	22025	7.30	20790	7.20	20190
13	5.70	12370	7.60	22650	10.30	40730	7.60	22650	6.80	17840	7.20	20190
14	5.30	10535	8.40	27750	9.20	33050	8.90	31025	6.60	16760	6.90	18410
15	5.30	10535	12.20	54510	8.30	27100	9.90	37900	6.50	16250	6.50	16250
16	5.50	11440	a17.05	97600	7.70	23275	10.90	44990	6.90	18410	5.90	13315
17	5.80	12840	15.95	86975	7.10	19590	9.20	33050	7.50	22025	5.30	10535
18	5.50	11440	12.50	56840	6.80	17840	8.40	27750	7.20	20190	4.80	8375
19	5.20	10080	10.50	42150	6.40	15755	7.70	23275	7.00	19000	4.40	6955
20	5.00	9200	10.40	41440	6.30	15260	7.60	22650	6.60	16760	4.90	8775
21	4.60	7600	11.90	52260	6.20	14770	7.60	22650	6.00	13800	4.30	6660
22	6.30	15260	11.30	47860	5.80	12840	7.90	24525	5.60	11900	3.70	5080
23	8.10	25800	9.90	37900	5.60	11900	8.10	25800	5.20	10080	4.50	7260
24	13.70	66540	10.10	39310	6.30	15260	8.20	26450	5.00	9200	4.90	8775
25	15.00	78000	12.85	59605	7.60	22650	7.20	20190	4.70	7985	5.30	10535
26	12.30	55280	14.35	72160	8.50	28400	6.80	17840	4.40	6955	5.10	9635
27	10.80	44280	13.10	61600	10.40	41440	6.30	15260	4.30	6660	5.30	10535
28	8.70	29700	11.40	48590	9.90	37900	6.20	14770	4.50	7260	6.20	14770
29	7.90	24525	.....	.....	9.40	34400	6.15	14525	4.80	8375	5.70	12370
30	7.20	20190	.....	.....	8.70	29700	b21.30	145830	4.80	8375	5.10	9635
31	6.40	15755	.....	.....	8.10	25800	....	....	4.70	7985	....	....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.60	7600	2.40	2260	1.80	1340	1.40	880	2.27	2035	3.02	3535
2	4.20	6380	2.20	1920	1.70	1220	1.50	990	2.18	1885	2.80	3060
3	3.70	5080	2.00	1605	1.70	1220	1.50	990	2.14	1820	2.71	2870
4	3.30	4165	1.90	1465	1.60	1100	1.50	990	2.10	1755	2.63	2705
5	3.20	3940	1.80	1340	1.60	1100	1.60	1100	2.08	1725	2.52	2485
6	3.20	3940	1.70	1220	1.50	990	1.70	1220	2.02	1635	2.42	2295
7	3.10	3715	1.60	1100	1.50	990	1.80	1340	1.95	1535	2.40	2260
8	3.10	3715	1.70	1220	1.50	990	1.70	1220	2.04	1665	2.38	2225
9	3.00	3490	1.50	990	1.50	990	1.60	1100	2.10	1755	2.30	2085
10	3.10	3715	1.60	1100	1.40	880	1.50	990	2.18	1885	2.05	1680
11	3.00	3490	1.50	990	1.40	880	1.50	990	2.24	1985	1.75	1280
12	2.80	3060	1.60	1100	1.40	880	1.60	1100	2.50	2445	1.95	1535
13	2.60	2640	1.50	990	1.30	775	1.70	1220	2.43	2315	2.35	2170
14	2.50	2445	1.40	880	1.30	775	2.00	1605	2.35	2170	2.98	3445
15	2.30	2085	1.50	990	1.40	880	2.30	2085	2.26	2020	4.54	7395
16	2.20	1920	2.30	2085	1.50	990	2.52	2485	2.20	1920	4.92	8860
17	2.40	2260	2.70	2850	1.40	880	2.32	2120	2.28	2050	5.12	9725
18	2.70	2850	2.40	2260	1.40	880	2.10	1755	2.32	2120	5.32	10625
19	2.60	2640	2.20	1920	1.30	775	1.95	1535	2.54	2525	5.65	12135
20	2.60	2640	2.20	1920	1.30	775	2.05	1680	2.62	2680	5.70	12370
21	2.50	2445	2.10	1755	1.40	880	2.11	1770	2.90	3270	d5.75	12605
22	2.50	2445	1.80	1340	1.50	990	2.31	2100	3.30	4165	5.63	12040
23	2.50	2445	1.80	1340	1.40	880	2.22	1955	3.95	5710	5.45	11205
24	2.60	2640	1.70	1220	1.40	880	2.20	1920	5.02	9285	5.10	9635
25	2.60	2640	1.60	1100	1.30	775	2.84	3145	5.32	10625	5.06	9460
26	2.70	2850	1.60	1100	1.30	775	3.02	3535	4.71	8025	5.04	9375
27	2.60	2640	1.60	1100	1.40	880	3.15	3825	4.13	6185	5.08	9545
28	2.60	2640	1.60	1100	1.40	880	3.06	3625	3.65	4965	5.20	10080
29	2.60	2640	1.70	1220	1.40	880	2.95	3380	3.44	4480	5.05	9420
30	2.60	2640	1.70	1220	1.40	880	3.01	3510	3.10	3715	4.84	8535
31	2.50	2445	1.80	1340	....	...	2.60	2640	....	....	4.66	7830

a. Max. 6 P. M., 17.8 = 105270 sec.-ft.
b. Max. 11 P. M., 23.9 = 184990 sec.-ft.
c. Max. 1.30 A. M., 23.7 = 182290 sec.-ft.
d. River frozen from December 21 to 31, inclusive.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.55	7430	6.78	17730	20.54	135794	6.83	18011	8.26	26840	4.96	9030	2.36	2190	1.83	1377	1.68	1196	2.95	3380	5.48	11348	8.30	27100
2	4.48	7199	6.12	14382	20.75	138465	6.42	15854	8.12	25930	5.04	9374	2.32	2120	1.85	1402	2.04	1665	2.62	2682	6.22	14868	7.60	22025
3	5.46	11250	6.24	14966	20.75	138465	5.88	13220	8.12	25930	5.36	10802	2.29	2068	1.86	1415	2.86	3186	2.68	2808	6.74	17510	7.03	19177
4	5.65	12135	6.18	14673	20.35	133435	6.01	13848	8.10	25800	5.68	12276	2.25	2002	1.80	1340	4.78	8297	3.02	3535	6.82	17954	6.52	16352
5	6.00	13800	6.12	14382	19.86	127630	5.81	12888	8.04	25410	6.02	13897	2.21	1936	1.72	1244	4.68	7908	3.50	4620	6.75	17565	6.20	14770
6	6.80	17840	6.12	14382	20.30	132820	6.00	13800	7.92	24650	5.98	13703	2.16	1854	1.62	1124	3.51	4643	3.50	4620	5.62	17025	6.10	14285
7	6.76	17620	6.10	14285	21.60	150090	6.23	14917	7.81	23962	5.92	13412	2.24	1986	1.60	1100	3.12	3760	3.52	4646	6.21	14819	5.60	11900
8	6.63	16919	5.81	12888	18.91	117010	5.88	13220	7.76	23650	5.62	11994	2.20	1920	1.60	1100	3.10	3715	3.71	5103	6.82	17954	5.25	10303
9	6.58	16658	6.14	14479	16.65	93680	5.21	10124	7.34	21034	5.21	10124	2.18	1887	1.60	1100	3.22	3985	3.80	5335	6.90	18410	5.00	9200
10	6.55	16505	6.22	14868	14.32	71896	4.42	7016	7.18	20070	5.15	9858	2.17	1870	1.60	1100	3.35	4278	3.85	5458	7.00	19000	4.80	8375
11	6.24	14966	6.18	14673	12.45	56450	4.40	6955	6.09	14236	5.02	9287	2.10	1755	1.65	1160	3.46	4528	3.79	5313	7.12	19710	4.20	6380
12	5.95	13558	6.05	14042	10.90	44990	4.36	6837	5.48	11340	4.82	8455	2.20	1920	1.74	1268	3.58	4804	3.54	4712	8.40	21400	4.40	6955
13	6.00	13800	5.86	13125	10.00	38600	4.30	6660	5.16	9902	4.68	7908	2.22	1953	1.85	1402	3.31	4188	3.26	4075	8.80	23900	4.72	8063
14	5.45	11205	5.52	11532	10.00	38600	4.25	6520	4.83	8495	4.51	7294	2.10	1755	2.00	1605	3.04	4390	3.02	3535	8.22	26580	4.66	7831
15	5.51	11486	5.50	11440	9.04	31970	4.16	6270	4.60	7600	4.22	6436	2.24	1986	1.91	1479	2.77	2997	2.72	2892	7.87	24347	4.60	7600
16	5.75	12605	5.32	10624	8.51	28465	4.08	6052	4.48	7199	4.10	6105	2.51	2465	1.85	1402	2.38	2225	2.20	1920	7.45	21712	4.00	5840
17	6.05	14043	5.51	11486	8.00	25150	4.00	5840	4.39	6926	3.96	5736	2.88	3228	1.75	1280	2.22	1953	2.41	2278	6.82	17954	3.65	4965
18	10.76	43996	5.62	11994	7.82	24025	4.20	6380	4.42	7016	3.91	5606	2.92	3314	1.71	1232	2.19	1904	2.48	2408	6.40	15755	3.40	4390
19	a14.32	71896	5.80	12840	7.88	24400	5.12	9724	4.48	7199	3.74	5178	2.86	3186	1.65	1160	2.08	1725	2.44	2334	6.20	14770	3.86	5482
20	13.06	61280	b6.06	14091	8.12	25930	5.40	10980	4.50	7260	3.62	4896	2.64	2724	1.64	1148	1.98	1577	2.50	2445	5.98	13703	4.55	7430
21	13.02	60960	6.32	15359	8.88	30890	6.32	15359	4.58	7532	3.44	4482	2.48	2408	1.59	1088	1.91	1479	2.56	2562	6.00	13800	4.80	8375
22	13.42	64206	6.46	16052	11.11	46492	7.32	20912	5.12	9724	3.26	4075	2.32	2120	1.52	1012	1.94	1521	2.48	2408	6.20	14770	5.10	9635
23	10.11	39381	6.64	16972	10.92	45132	7.15	19890	5.26	10347	3.02	3535	2.20	1920	1.48	968	2.08	1725	2.40	2260	6.40	15755	5.60	11900
24	10.08	39168	6.82	17954	10.62	43002	7.02	19118	5.35	10758	2.90	3270	2.15	1832	1.56	1056	3.12	3760	2.61	2661	6.60	16760	6.00	13800
25	9.46	34820	7.04	19236	10.52	42292	9.24	33220	5.35	10758	2.67	2787	2.12	1786	1.92	1493	6.00	13800	2.82	3102	7.90	18410	6.50	16250
26	8.76	30090	7.10	19590	10.60	42860	12.48	56684	5.28	10436	2.58	2601	2.08	1725	2.00	1605	5.36	10798	2.96	3402	9.03	31902	6.30	15260
27	8.12	25930	7.30	20790	9.72	36640	12.25	54895	5.24	10258	2.56	2542	1.98	1577	2.10	1755	4.72	8063	3.03	3557	9.00	31700	5.80	12840
28	8.72	29830	c15.67	84315	8.73	29895	11.64	50342	5.18	9991	2.60	2640	1.90	1465	2.11	1770	4.12	6160	3.73	5149	8.30	27100	5.80	12840
29	7.92	24650	....	.....	8.15	26125	9.96	38320	5.12	9724	2.51	2464	1.85	1402	1.93	1507	3.70	5080	4.02	5893	7.85	24225	6.00	13800
30	7.51	22088	....	.....	7.15	19890	8.82	30485	5.12	9724	2.43	2316	1.85	1402	1.77	1304	3.32	4210	4.60	7600	8.40	27750	14.75	75720
31	7.12	19710	....	.....	7.21	20250	....	.....	5.10	9635	....	.....	1.81	1352	1.73	1256	....	.....	5.20	10080	....	.....	13.60	65700

a. Max. 3.15 P.M. 15.6 = 83650 sec.-ft. b. Interpolated. c. Max. 9 P.M. 19.18 = 119980 sec.-ft.

Daily Gage Heights and Discharges of Allegheny River at Kittanning, Pa., for 1911.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	11.55	49685	10.50	42150	6.30	15260	8.62	29180	6.83	18011	3.80	5335	4.00	5840	1.55	1045	7.90	24525	11.10	46420
2	11.32	48004	9.50	35100	5.50	11440	7.81	23962	7.10	19590	3.78	5289	3.60	4850	1.50	990	7.00	19000	c18.92	117120
3	12.50	56840	8.52	28530	5.23	10214	7.40	21400	7.21	20250	3.75	5195	3.35	4277	1.85	1402	6.20	14770	14.45	73045
4	14.34	72072	8.30	27100	4.62	7677	7.14	19830	7.51	22087	3.70	5080	3.00	3490	1.95	1535	5.10	9635	11.05	46060
5	12.55	57235	7.90	24525	4.12	6160	6.31	15310	6.85	18125	3.65	4965	2.50	2445	2.00	1605	4.50	7260	9.60	35800
6	10.80	44280	7.20	20190	3.92	5632	8.93	31227	6.35	15507	3.60	4850	2.10	1755	2.50	2445	7.15	19890	8.65	29375
7	9.95	38250	6.50	16250	3.89	5312	10.94	45274	6.00	13800	3.60	4850	2.00	1605	2.85	3165	8.48	28270	8.40	27750
8	8.55	28725	5.83	12982	3.46	4482	11.25	47500	5.46	11253	3.55	4735	2.00	1605	2.90	3270	7.95	24838	9.85	37550
9	8.10	25800	5.80	12840	3.17	3872	10.95	45345	5.20	10080	3.55	4735	1.95	1535	2.65	2745	8.85	30688	9.05	32038
10	7.60	22650	5.83	12982	3.11	3737	10.60	42860	5.02	9287	3.50	4620	1.95	1535	2.40	2260	10.10	39310	8.30	27100
11	7.00	19000	5.85	13077	3.87	5506	8.72	29830	4.82	8455	3.50	4620	1.95	1535	2.25	2002	8.58	28920	7.50	22025
12	8.77	30155	5.30	10525	4.62	7677	8.35	27425	4.80	8375	3.75	5195	1.95	1535	2.10	1755	7.20	20190	6.80	17840
13	13.30	63220	5.30	10525	5.28	10476	7.99	25088	4.75	8080	4.50	7260	1.93	1507	1.95	1535	6.48	16151	6.35	15508
14	15.75	85075	5.50	11440	7.24	20430	7.24	20430	4.68	7793	4.95	8987	1.93	1507	1.80	1340	5.85	13078	5.95	13558
15	19.06	118660	9.00	31700	8.50	28400	8.76	30090	4.60	7600	4.90	8775	1.92	1493	1.70	1220	b12.32	55436	6.10	14285
16	16.64	93584	9.80	37200	8.24	26710	8.85	30687	4.52	7328	4.80	8375	1.92	1493	2.60	2640	14.25	71280	5.90	13315
17	13.19	62329	9.30	33725	7.92	24650	8.85	30687	4.45	7107	4.60	7600	1.92	1493	3.25	4052	11.75	51150	5.60	11900
18	11.30	47860	10.72	43712	7.28	20670	8.15	26125	4.00	5840	4.15	6242	1.90	1465	3.50	4620	10.08	39168	9.80	37200
19	9.62	35940	13.85	67815	7.48	21900	8.70	29700	4.32	6719	3.90	5580	1.90	1465	3.30	4165	8.20	26450	11.10	46420
20	8.52	28530	12.60	57630	7.48	21900	7.80	23900	4.28	6604	3.70	5080	1.87	1427	2.95	3380	6.70	17290	9.60	35800
21	7.00	19000	10.53	49539	7.28	20670	10.32	40872	4.25	6520	3.20	3940	1.85	1402	2.70	2850	6.00	13800	8.35	27425
22	7.00	19000	9.40	34400	7.31	20851	9.82	37340	4.20	6380	2.90	3270	1.85	1402	2.50	2445	5.40	10980	7.40	21400
23	6.80	17840	7.95	24837	8.89	30957	10.05	38955	4.16	6270	2.55	2542	1.85	1402	2.25	2002	5.05	9418	6.60	16760
24	6.50	16250	7.10	19590	8.10	25800	9.42	34542	4.12	6160	2.70	2850	1.90	1465	2.20	1920	4.60	7600	6.30	15260
25	5.80	12840	6.90	18410	7.81	23962	8.70	29700	4.10	6105	3.70	5080	1.85	1402	2.30	2085	4.30	6660	6.00	13800
26	5.50	11440	6.70	17290	7.45	21712	7.82	24025	4.06	5999	3.90	5580	1.85	1402	3.70	5080	4.10	6105	5.80	12840
27	5.80	12840	7.20	20190	8.21	26515	7.25	20490	4.02	5893	4.10	6105	1.80	1340	3.50	4620	4.00	5840	5.50	11440
28	11.55	49685	6.50	16250	9.85	37550	6.80	17840	4.00	5840	4.25	6520	1.75	1280	5.10	9635	4.60	7600	5.25	10303
29	16.30	90320	....	.....	11.00	45700	6.49	16200	3.95	5710	4.25	6520	1.75	1280	8.80	30350	6.40	15755	5.00	9200
30	14.50	73490	....	.....	10.11	39381	6.67	17131	3.90	5580	4.20	6380	1.70	1220	a13.90	68240	7.50	22025	4.70	7985
31	12.50	56840	....	.....	9.35	34062	....	.....	3.85	5457	....	....	1.65	1160	9.45	34750	....	.....	4.60	7600

a. Max. 10 A. M., 14.0 = 69100 sec.-ft. b. Max. 6 P. M., 15.0 = 78000 sec.-ft. c. Max. 6 A. M., 19.8 = 126940 sec.-ft.

Estimated Monthly Discharge of Allegheny River at Kittanning, Pa.

[Drainage area, 9010 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
September	7600	1605	3042	0.338	0.377
October	13800	2640	6006	0.667	0.769
November	5335	2085	2984	0.331	0.369
December	56060	2085	10586	1.175	1.354
1905					
January	88400	14285	44950	4.989	5.752
March 18-31	240250	34400	.....	.....	.....
April	42860	9635	18769	2.083	2.324
May 1-5, 10-31	20190	5580	.....	.....	.....
June	38600	4165	14018	1.556	1.736
July	48590	3715	16653	1.848	2.131
August	22960	3940	8688	0.964	1.111
September	21400	2445	6215	0.690	0.770
October	35100	3060	11216	1.245	1.435
November	53000	7260	14740	1.636	1.826
December	77080	6660	29373	3.260	3.758
1906					
January	60800	10980	27034	3.000	3.459
February	15260	5580	7658	0.850	0.885
March	69100	5335	16694	1.853	2.136
April	62410	8775	30312	3.364	3.753
May	19590	5840	10416	1.156	1.333
June	33725	2850	6637	0.737	0.822
July	2445	1465	2035	0.226	0.261
August	25150	1605	6133	0.681	0.785
September	4850	1605	2900	0.322	0.359
October	24525	2445	13812	1.533	1.767
November	39310	7260	17048	1.892	2.111
December	67390	9200	26871	2.982	3.438
The year	69100	1465	13964	1.550	21.101
1907					
January	66540	10535	37796	4.195	4.837
February	11900	5840	8550	0.949	0.988
March	86500	6380	37872	4.203	4.846
April	53000	8375	20148	2.236	2.495
May	38600	10980	20718	2.299	2.651
June	37900	7260	16280	1.807	2.016
July	19000	3490	7306	0.811	0.935
August	7600	990	2147	0.238	0.275
September	5840	1220	3114	0.346	0.386
October	21095	3940	10186	1.131	1.304
November	37200	6105	17877	1.984	2.213
December	80810	5080	22883	2.540	2.928
The year	86500	990	17076	1.895	25.874
1908					
January	44990	6105	19014	2.110	2.433
February	190210	10080	40623	4.509	4.863
March	114730	10980	59263	6.577	7.582
April	44990	15755	27891	3.096	3.455
May	61600	19590	37138	4.122	4.752
June	27100	4390	9522	1.057	1.179
July	25800	4165	9105	1.011	1.165
August	4620	1305	2743	0.304	0.350
September	1305	850	996	0.111	0.124
October	1185	850	975	0.108	0.125
November	1565	850	1175	0.130	0.145
December	16250	1305	4356	0.483	0.557
The year	190210	850	17726	1.968	26.730

Estimated Monthly Discharge of Allegheny River at Kittanning, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
January	78000	7600	27200	3.019	3.481
February	105270	6380	40342	4.477	4.662
March	50780	11900	27894	3.096	3.569
April	184990	14525	28142	3.123	3.484
May	182290	6660	33898	3.762	4.337
June	20190	5080	12014	1.333	1.487
July	7600	1920	3234	0.359	0.414
August	2850	880	1421	0.158	0.182
September	1340	775	934	0.104	0.116
October	3825	880	1897	0.211	0.243
November	10625	1535	3345	0.371	0.414
December	12605	1280	6596	0.732	0.844
The year	184990	775	15576	1.729	23.133
1910					
January	83650	7199	25710	2.853	3.289
February	119980	10624	17255	0.191	0.199
March	150090	19890	63269	7.022	8.095
April	56684	5840	18145	2.014	2.247
May	26840	6926	14172	1.573	1.814
June	13897	2316	7067	0.784	0.874
July	3314	1352	2003	0.222	0.256
August	1770	1100	1299	0.144	0.166
September	13800	1196	4314	0.479	0.534
October	10080	1920	3960	0.440	0.507
November	31902	11348	19582	2.175	2.422
December	75720	4390	15305	1.699	1.949
The year	150090	1100	16007	1.633	22.352
1911					
January	118660	11440	45401	5.039	5.810
February	67815	10525	26804	2.975	3.098
March	45700	3737	19009	2.110	2.433
April	47500	15310	29098	3.214	3.586
May	22087	5457	9607	1.066	1.229
June	8987	2542	5538	0.615	0.686
July	5840	1160	1891	0.210	0.242
August	69100	990	6811	0.756	0.872
September	78000	5840	22103	2.453	2.737
October	126940	7600	27552	3.058	3.526
10 months	126940	990	19381	2.150	24.219

ALLEGHENY RIVER AT RED HOUSE, N. Y.

This station, situated on Red House Bridge, near the station of the Erie and Pennsylvania railroads, at Red House, Cattaraugus County, N. Y., was established September 4, 1903, by R. E. Horton, for the U. S. Geological Survey, and is maintained by the State Engineer of New York.

A standard chain gage, measuring 24.16 feet from marker to bottom of weight, is fastened to the upstream side of the bridge, near the middle of the left span. The elevation of the corner of the downstream side of the left abutment is 1340.90. The elevation of the zero of the gage is 1319.81.

Measurements are taken from the downstream side of bridge. The initial point for soundings is the left end of downstream side of bridge.

The channel is straight for a distance of 800 feet above and below the station. The bed of the stream is of gravel and is permanent. The current is well distributed.

The right bank is high and does not overflow. The left bank overflows only at flood stages. The greatest range of gage heights is about 11 feet.

The gage is read twice daily by O. A. Gates.

The drainage area above the station is 1,640 square miles.

Discharge Measurements of Allegheny River at Red House, N. Y.

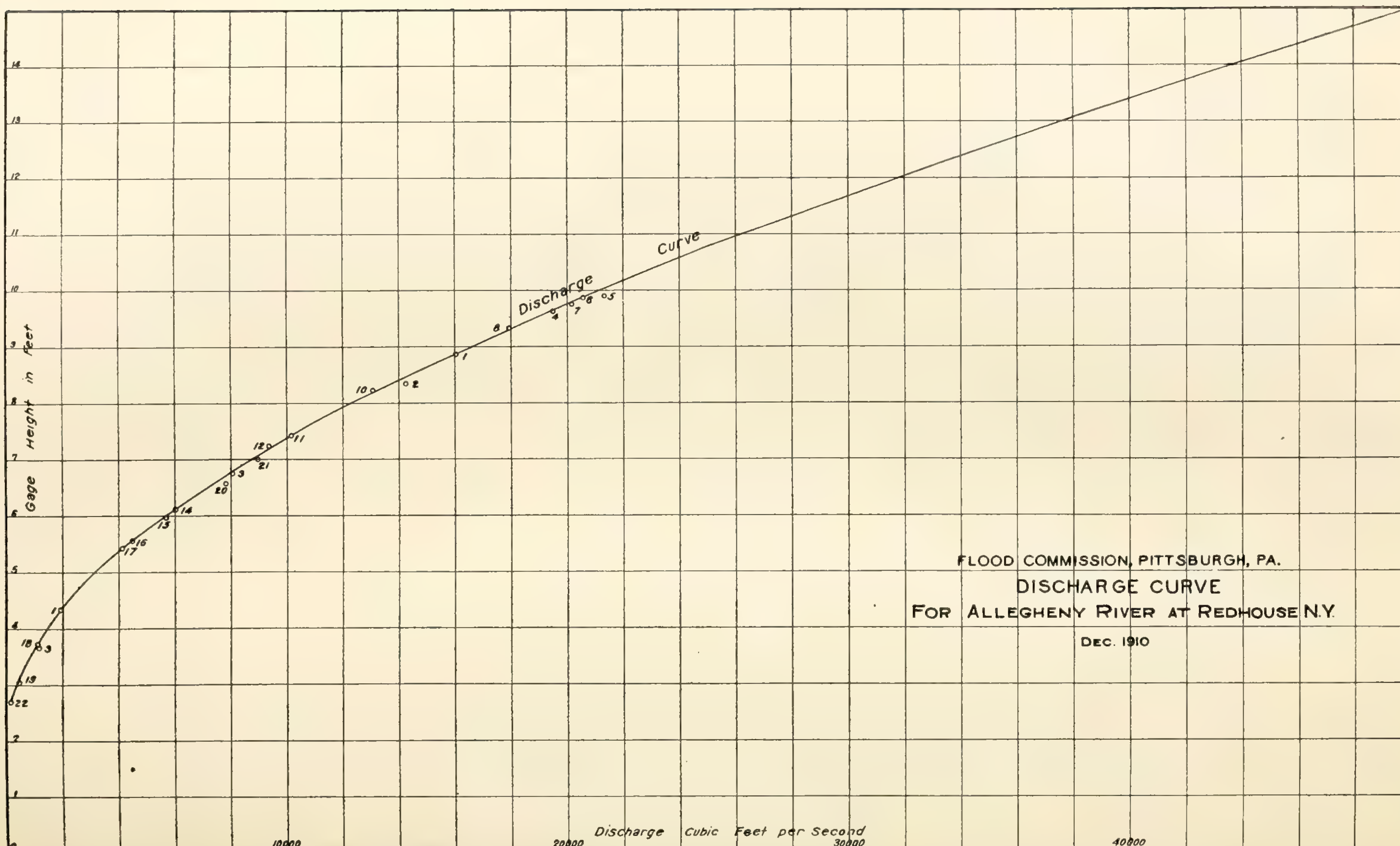
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1903			Feet	Sq. ft.	Ft. per sec.	Feet	Sec.-ft.
Sept.	4	R. E. Horton	...	....	....	4.33	1909
1904							
April	10	do	...	2807	4.97	8.35	14220
July	18	C. C. Covert	...	1198	0.99	3.68	1188
1905							
Mar.	25	W. B. Freeman	368	3313	5.88	9.63	19470
Mar.	27	do	368	3412	6.25	9.91	21320
Mar.	28	do	368	3385	6.07	9.88	20570
Mar.	28	do	368	3353	6.01	9.77	20160
Mar.	29	do	368	3168	5.65	9.34	17930
Mar.	30	do	368	3007	5.33	8.88	16040
Mar.	31	do	368	2764	4.73	8.24	13060
April	1	do	368	2489	4.09	7.44	10170
April	1	do	368	2415	3.89	7.24	9386
April	2	do	368	2286	3.51	6.77	8029
April	3	do	368	2045	2.94	6.11	6015
April	3	do	363	2003	2.84	5.98	5681
April	4	do	363	1867	2.40	5.58	4484
April	5	do	363	1797	2.32	5.41	4161
July	31	Murphy and Covert	362	1214	0.93	3.74	1135
Aug.	26	C. C. Covert	357	993	0.45	3.05	446
1906							
April	16	do	370	2250	3.49	6.59	7820
1907							
April	16	do	366	2390	3.75	7.00	8970
1908							
Oct.	20	C. R. Adams	355	840	0.17	2.70	145
1909							
Aug.	18a	C. C. Covert	80	103	2.63	2.91	271

a. Wading measurement.

Rating Table for Allegheny River at Red House, N. Y.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
2.70	145	4.40	2043	6.10	5950	7.80	11530	9.50	18790
.80	220	.50	2200	.20	6245	.90	11910	.60	19245
.90	295	.60	2365	.30	6545	8.00	12300	.70	19705
3.00	380	.70	2540	.40	6845	.10	12705	.80	20170
.10	470	.80	2725	.50	7150	.20	13120	.90	20635
.20	560	.90	2920	.60	7460	.30	13540	10.00	21100
.30	655	5.00	3130	.70	7775	.40	13960	.20	22045
.40	755	.10	3350	.80	8090	.50	14380	.40	23025
.50	866	.20	3580	.90	8410	.60	14800	.60	24045
.60	978	.30	3820	7.00	8740	.70	15225	.80	25105
.70	1095	.40	4065	.10	9070	.80	15660	11.00	26200
.80	1216	.50	4315	.20	9400	.90	16100	.20	27320
.90	1341	.60	4750	.30	9735	9.00	16540	.40	28840
4.00	1471	.70	4830	.40	10080	.10	16985	.60	29560
.10	1605	.80	5100	.50	10430	.20	17430	.80	30680
.20	1745	.90	5375	.60	10790	.30	17880	12.00	31800
.30	1891	6.00	5660	.70	11155	.40	18335	...	....

PLATE 94


FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR ALLEGHENY RIVER AT REDHOUSE N.Y.
DEC. 1910
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
0
10000
20000
30000
40000
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1904.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	4.70	2540	6.10	5950	7.30	9735	6.30	6545	7.32	9804	3.25	608	3.32	675	3.45	811	4.50	2200	3.90	1341	3.40	755
2	....	....	4.50	2200	6.85	8250	8.35	13750	5.90	5375	6.55	7305	3.55	922	3.28	636	3.38	735	4.18	1717	3.85	1279	3.40	755
3	....	....	4.35	1967	8.50	14380	7.85	11720	5.55	4443	6.05	5805	3.55	922	3.20	560	3.45	811	4.05	1538	3.80	1216	3.40	755
4	....	....	4.00	1471	8.68	15140	7.28	9668	5.25	3700	5.55	4443	3.40	755	3.20	560	3.70	1095	4.00	1471	3.72	1119	3.40	755
5	....	....	4.30	1891	8.00	12300	6.88	8346	4.98	3088	5.32	3869	3.48	844	3.20	560	3.45	811	3.88	1316	3.62	1001	3.90	1341
6	4.50	2200	4.40	2043	7.28	9668	6.55	7305	4.82	2764	5.05	3240	3.82	1241	3.20	560	3.40	755	3.78	1192	3.50	866	3.35	705
7	4.50	2200	8.60	14800	8.75	15443	6.25	6395	4.60	2365	4.85	2823	3.90	1341	3.20	560	3.32	675	3.70	1095	3.50	866	3.32	675
8	4.50	2200	10.70	24570	10.50	23530	6.12	6009	4.48	2169	4.60	2365	3.75	1156	3.12	488	3.30	655	3.70	1095	3.50	866	3.30	655
9	4.50	2200	9.85	20402	10.10	21570	7.80	11530	4.40	2043	4.60	2365	3.60	978	3.10	470	3.22	579	3.80	1216	3.50	866	3.30	655
10	4.50	2200	9.00	16540	9.05	16763	8.32	13624	4.25	1818	4.42	2074	6.05	5805	3.00	380	3.20	560	4.00	1471	3.50	866	3.35	705
11	4.50	2200	8.10	12705	7.82	11606	7.78	11455	4.20	1745	4.25	1818	6.00	5660	3.00	380	3.20	560	4.70	2540	3.45	811	3.52	888
12	4.50	2200	7.00	8740	6.75	7933	7.50	10430	4.12	1633	4.00	1471	5.20	3580	3.00	380	3.20	560	5.00	3130	3.40	755	3.60	978
13	4.50	2200	6.00	5660	6.12	6009	7.10	9070	4.05	1538	3.95	1406	5.45	4190	3.00	380	3.12	488	5.10	3350	3.50	866	3.60	978
14	4.50	2200	5.48	4265	5.50	4315	6.50	7150	3.90	1341	3.80	1216	4.95	3025	3.00	380	3.10	470	5.00	3130	3.50	866	3.55	922
15	....	....	4.90	2920	5.12	3396	6.00	5660	4.05	1538	3.80	1216	4.40	2043	3.00	380	3.10	470	4.70	2540	3.45	811	3.50	866
16	4.50	2200	4.55	2283	4.85	2823	5.50	4315	4.22	1774	3.75	1156	4.15	1675	3.00	380	3.10	470	4.45	2122	3.45	811	3.50	866
17	....	....	4.40	2043	4.60	2365	5.70	4830	4.15	1675	3.55	922	3.95	1406	3.00	380	3.20	560	4.25	1818	3.40	755	3.50	866
18	4.50	2200	4.30	1891	4.68	2505	5.80	5100	4.20	1745	3.50	866	3.80	1216	3.00	380	3.25	608	4.10	1605	3.35	705	3.50	866
19	4.50	2200	4.10	1605	4.70	2540	5.65	4700	6.15	6098	3.50	866	3.70	1095	3.00	380	3.22	579	3.95	1406	3.30	655	3.50	866
20	4.50	2200	3.95	1406	5.45	4190	5.35	3943	6.20	6245	3.48	844	3.50	866	3.15	515	3.12	488	3.78	1192	3.30	655	3.50	866
21	4.60	2365	....	....	5.88	5320	5.20	3580	5.72	4884	3.52	888	3.48	844	3.60	978	3.05	425	3.68	1072	3.30	655	3.52	888
22	7.00	8740	....	....	5.55	4443	5.20	3580	5.35	3943	3.62	1001	3.38	735	4.00	1471	3.00	380	4.15	1675	3.30	655	3.60	978
23	9.95	20868	....	....	8.25	13330	5.00	3130	5.15	3465	3.80	1216	3.30	655	4.35	1967	3.00	380	5.10	3350	3.30	655	3.62	1001
24	9.40	18335	4.58	2332	8.85	15880	4.82	2764	5.80	5100	3.65	1037	3.58	956	4.40	2043	3.05	425	5.10	3350	3.30	655	5.25	3700
25	8.95	16320	4.38	2013	8.98	16452	5.22	3628	5.90	5375	3.48	844	3.45	811	4.15	1675	4.20	1745	4.90	2920	3.30	655	5.75	4965
26	8.10	12705	4.00	1471	11.10	26760	5.35	3943	5.65	4700	3.40	755	3.32	675	3.90	1341	4.75	2633	4.60	2365	3.25	608	5.45	4190
27	6.90	8410	3.95	1406	10.70	24570	5.20	3580	6.60	7460	3.28	636	3.30	655	3.90	1341	4.70	2540	4.60	2365	3.40	755	6.05	5805
28	6.45	6998	3.85	1279	9.50	18790	5.80	5100	6.45	6998	3.20	560	3.30	655	4.00	1471	4.45	2122	4.50	2200	3.30	655	8.05	12503
29	6.10	5950	4.10	1605	8.20	13120	6.30	6545	5.78	5046	3.20	560	3.68	1072	3.70	1095	4.15	1675	4.30	1891	3.20	560	6.90	8410
30	5.40	4065	....	....	7.25	9568	6.70	7775	5.65	4700	3.20	560	3.65	1037	3.52	888	4.50	2200	4.20	1745	3.25	608	6.20	6245
31	5.00	3130	....	....	6.88	8346	....	....	7.50	10430	....	....	3.45	811	3.45	811	....	....	4.00	1471	....	...	5.45	4190

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1905.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	5.52	4366	4.50	2200	4.43	2090	7.35	9908	4.45	2122	3.48	844	3.95	1406	3.81	1229	2.95	338	2.80	220	3.85	1279	7.00	8740
2	5.76	4992	4.85	2823	4.43	2090	6.45	6998	4.30	1891	3.40	755	4.02	1498	3.58	956	2.95	338	2.80	220	4.10	1605	5.10	3350
3	5.86	5265	4.95	3025	4.43	2090	6.00	5660	4.25	1818	3.30	655	4.08	1578	3.44	799	2.92	312	2.90	295	4.00	1471	6.55	7305
4	4.46	2137	4.75	2633	4.43	2090	5.55	4443	4.18	1717	3.30	655	4.05	1538	3.31	665	2.90	295	3.00	380	4.00	1471	7.15	9235
5	5.16	3488	4.74	2614	4.43	2090	5.35	3943	4.00	1471	3.30	655	4.60	2365	3.14	506	2.90	295	3.12	488	4.00	1471	6.65	7618
6	5.16	3488	4.69	2523	4.43	2090	5.18	3534	4.00	1471	3.45	811	5.00	3130	3.11	479	3.00	380	3.15	515	4.80	2725	6.30	6545
7	4.91	2941	4.54	2266	4.43	2090	5.00	3130	4.25	1818	5.20	3580	5.40	4065	3.26	617	3.00	380	3.10	470	5.00	3130	5.85	5238
8	....	....	4.54	2266	4.43	2090	4.85	2823	4.35	1967	5.25	3700	5.85	5238	3.38	735	3.00	380	2.88	280	5.00	3130	5.50	4315
9	4.34	1952	4.54	2266	4.58	2332	4.60	2365	4.18	1717	4.85	2823	5.30	3820	3.36	715	2.90	295	2.80	220	5.20	3580	5.25	3700
10	4.21	1760	4.52	2233	4.83	2784	4.55	2283	4.00	1471	4.35	1967	4.45	2122	3.31	665	2.85	258	2.72	160	5.20	3580	5.05	3240
11	4.26	1833	4.44	2106	5.02	3174	4.50	2200	3.90	1341	4.45	2122	4.45	2122	3.26	617	2.95	338	2.75	183	4.60	2365	4.85	2823
12	4.26	1833	4.44	2106	5.22	3628	4.65	2453	3.80	1216	4.70	2540	4.85	2823	3.48	844	3.70	1095	3.50	866	4.60	2365	4.75	2633
13	5.06	3262	4.44	2106	5.17	3511	4.90	2920	3.80	1216	4.50	2200	5.10	3350	3.46	822	3.72	1119	4.50	2200	4.50	2200	4.55	2283
14	5.46	4215	4.44	2106	4.92	2962	4.70	2540	3.80	1216	4.30	1891	5.25	3700	3.61	990	3.58	956	4.25	1818	4.38	2013	4.35	1967
15	5.01	3152	4.39	2028	4.92	2962	4.60	2365	3.80	1216	4.02	1497	5.20	3580	3.56	933	3.35	705	3.95	1406	4.30	1891	4.15	1675
16	4.81	2745	4.39	2028	4.92	2962	4.60	2365	3.72	1119	3.92	1367	4.60	2365	3.54	911	3.30	655	3.75	1156	4.30	1891	3.85	1279
17	4.71	2559	4.39	2028	4.92	2962	4.50	2200	3.70	1095	4.40	2043	4.25	1818	3.46	822	3.30	655	3.55	922	4.20	1745	3.50	866
18	4.64	2435	4.39	2028	6.52	7212	4.50	2200	3.70	1095	5.25	3700	4.05	1538	3.38	735	3.50	866	3.40	755	4.20	1745	3.60	978
19	4.50	2200	4.36	1982	11.42	28552	4.55	2283	3.68	1072	5.50	4315	3.98	1445	3.28	636	3.30	655	4.05	1538	4.00	1471	3.85	1279
20	4.37	1997	4.34	1952	11.57	29392	4.85	2823	3.60	978	5.30	3820	3.82	1241	3.21	570	3.20	560	4.60	2365	4.00	1471	3.55	922
21	4.27	1847	4.34	1952	11.67	29952	7.00	8740	3.60	978	5.60	4570	3.68	1072	3.16	524	3.20	560	4.90	2920	3.70	1095	4.10	1605
22	4.23	1789	4.33	1937	11.12	26872	7.65	10973	3.55	922	7.18	9334	3.56	933	3.14	506	3.12	488	5.00	3130	3.45	811	6.40	6845
23	4.15	1675	4.33	1937	9.94	20821	6.40	6845	3.50	866	6.90	8410	3.38	735	3.06	434	3.02	398	5.00	3130	3.45	811	6.20	6245
24	4.10	1605	4.33	1937	9.64	19429	5.65	4700	3.48	844	6.30	6545	3.26	617	3.01	389	3.00	380	4.85	2823	3.45	811	5.75	4965
25	3.85	1279	4.33	1937	9.64	19429	5.35	3943	3.40	755	5.60	4570	3.51	877	2.96	346	2.92	312	4.60	2365	3.65	1037	5.55	4443
26	3.40	755	4.33	1937	9.70	19705	5.12	3396	3.40	755	5.15	3465	3.51	877	2.98	363	2.90	295	4.35	1967	3.35	705	5.15	3465
27	3.35	705	4.33	1937	9.92	20728	4.90	2920	3.40	755	4.85	2823	3.31	665	3.00	380	2.90	295	4.15	1675	3.40	755	4.85	2823
28	4.10	1605	4.41	2059	9.76	19984	4.70	2540	3.58	956	4.45	2122	3.26	617	2.98	363	2.85	258	3.95	1406	3.45	811	4.65	2453
29	4.20	1745	....	....	9.30	17880	4.60	2365	3.50	866	4.25	1818	3.88	1316	2.95	338	2.80	220	3.75	1156	6.40	6845	6.00	5660
30	4.40	2043	....	....	8.80	15660	4.60	2365	3.50	866	4.05	1538	4.16	1689	2.95	338	2.80	220	3.62	1001	7.30	9735	7.50	10430
31	4.45	2122	....	....	8.15	12913	....	....	3.50	866	....	....	3.94	1393	2.95	338	....	....	3.60	978	....	....	6.65	7618

January, February and March subject to error on account of ice.

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1906.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.20	6245	4.55	2283	3.60	978	7.15	9235	4.25	1818	4.75	2633	3.00	380	3.00	380	3.00	380	4.10	1605	5.25	3700	4.20	1745
2	5.80	5100	4.35	1967	3.60	978	6.80	8090	4.30	1891	4.45	2122	3.00	380	2.95	338	3.00	380	3.75	1156	4.95	3025	4.30	1891
3	5.25	3700	4.15	1675	3.65	1037	6.25	6395	5.50	4315	4.25	1818	3.10	470	2.90	295	3.05	425	3.50	866	4.90	2920	4.20	1745
4	5.70	4830	4.20	1745	4.75	2633	6.10	5951	5.25	3700	4.05	1538	3.10	470	2.90	295	3.40	755	3.50	866	4.90	2920	4.00	1471
5	6.05	5805	4.00	1471	4.75	2633	6.65	7618	5.35	3943	3.85	1279	3.05	425	3.55	922	3.45	811	3.50	866	4.80	2725	4.05	1538
6	5.50	4315	3.90	1341	4.25	1818	6.75	7933	5.30	3820	4.15	1675	3.10	470	3.30	655	3.30	655	4.00	1471	4.70	2540	5.60	4570
7	5.20	3580	3.85	1279	4.20	1745	6.70	7775	4.85	2823	4.10	1605	3.10	470	3.30	655	3.05	425	6.00	5660	4.45	2122	8.60	14800
8	4.80	2725	3.80	1216	4.10	1605	6.25	6395	4.75	2633	3.95	1406	3.00	380	3.60	978	3.00	380	5.85	5238	4.25	1818	7.25	9568
9	4.55	2283	3.85	1279	4.00	1471	5.95	5518	4.60	2365	3.80	1216	2.90	295	3.60	978	2.90	295	5.50	4315	4.15	1675	6.45	6998
10	4.30	1891	3.80	1216	3.85	1279	6.65	7618	4.80	2725	3.70	1095	2.90	295	3.70	1095	2.80	220	5.25	3700	4.00	1471	6.15	6098
11	4.55	2283	3.75	1156	3.80	1216	7.10	9070	4.80	2725	3.65	1037	2.90	295	3.80	1216	2.80	220	5.10	3350	4.10	1605	6.90	8410
12	4.35	1967	3.80	1216	3.80	1216	6.40	6845	4.70	2540	3.55	922	2.90	295	4.00	1471	2.70	145	5.00	3130	4.20	1745	6.40	6845
13	4.30	1891	3.65	1037	3.70	1095	6.60	7460	4.55	2283	3.40	755	2.85	258	3.75	1156	2.80	220	5.00	3130	4.35	1967	6.55	7305
14	4.20	1745	3.70	1095	3.60	978	6.45	6998	4.65	2453	3.30	655	2.80	220	3.50	866	3.00	380	5.40	4065	4.20	1745	6.65	7618
15	4.15	1675	3.75	1156	3.60	978	6.30	6545	4.75	2633	3.30	655	2.80	220	3.40	755	3.00	380	5.15	3465	4.10	1605	8.80	15660
16	4.55	2283	3.75	1156	3.60	978	6.45	6998	4.50	2200	3.30	655	2.80	220	3.30	655	3.00	380	4.85	2823	4.00	1471	8.80	15660
17	4.75	2633	3.65	1037	3.50	866	6.35	6695	5.45	4190	3.30	655	2.80	220	3.15	515	2.90	295	4.55	2283	4.05	1538	6.20	6245
18	4.70	2540	3.50	866	3.50	866	6.00	5660	5.35	3943	3.30	655	2.80	220	3.00	380	2.80	220	4.30	1891	4.75	2633	6.65	7618
19	4.60	2365	3.50	866	3.40	755	5.55	4443	4.90	2920	3.60	978	2.80	220	3.10	470	2.80	220	4.20	1745	5.75	4965	6.65	7618
20	4.60	2365	3.50	866	3.20	560	5.35	3943	4.60	2365	3.45	811	2.85	258	3.10	470	2.80	220	5.00	3130	5.50	4315	6.45	6998
21	6.50	7150	3.60	978	3.20	560	5.50	4315	4.25	1818	3.40	755	2.90	295	3.90	1341	3.00	380	5.10	3350	6.25	6395	6.45	6998
22	7.70	11155	3.90	1341	3.20	560	5.10	3350	4.05	1538	3.30	655	2.85	258	4.05	1538	4.00	1471	4.75	2633	6.55	7305	6.45	6998
23	8.10	12705	3.80	1216	3.10	470	4.70	2540	3.95	1406	3.30	655	2.80	220	3.80	1216	3.75	1156	4.65	2453	5.80	5100	6.45	6998
24	8.25	13330	3.80	1216	3.00	380	5.30	3820	4.00	1471	3.35	705	2.80	220	3.60	978	3.45	811	4.50	2200	5.35	3943	6.10	5950
25	7.60	10790	3.70	1095	3.30	655	5.20	3580	4.85	2823	3.20	560	2.80	220	3.55	922	3.30	655	4.80	2725	5.00	3130	....	....
26	7.00	8740	3.75	1156	3.40	755	4.85	2823	4.60	2365	3.20	560	2.80	220	3.35	705	3.15	515	5.05	3240	4.75	2633	....	....
27	6.50	7150	3.60	978	5.25	3700	4.80	2725	4.70	2540	3.20	560	2.70	145	3.20	560	3.10	470	4.70	2540	4.50	2200	....	....
28	5.85	5238	3.50	866	8.40	13960	4.70	2540	5.30	3820	3.10	470	2.70	145	3.20	560	3.00	380	4.50	2200	4.60	2365	....	....
29	5.30	3820	....	....	7.30	9735	4.50	2200	5.35	3943	3.10	470	2.80	220	3.20	560	3.00	380	4.95	3025	4.55	2283	....	....
30	4.95	3025	....	....	6.90	8410	4.40	2043	5.05	3240	3.00	380	2.80	220	3.10	470	3.55	922	4.50	2200	4.40	2043	....	....
31	4.85	2823	....	....	7.75	11343	....	....	5.20	3580	....	...	3.00	380	3.10	470	....	...	5.20	3580	....	....	....	....

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1907.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	4.25	1818	....	...	6.40	6845	5.80	5100	4.40	2043	5.50	4315	3.20	560	2.70	145	3.20	560	3.60	978	3.80	1216
2	....	....	4.20	1745	3.50	866	5.70	4830	5.60	4570	5.15	3465	5.50	4315	3.20	560	2.70	145	3.10	470	3.60	978	3.80	1216
3	....	....	4.20	1745	....	...	5.30	3820	5.20	3580	6.10	5950	5.30	3820	3.20	560	2.80	220	3.00	380	3.50	866	3.70	1095
4	....	....	4.25	1818	....	...	5.00	3130	6.10	5950	5.50	4315	5.00	3130	3.20	560	2.80	220	5.00	3130	5.20	3580	3.60	978
5	....	....	4.25	1818	....	...	5.00	3130	6.50	7150	5.40	4065	4.50	2200	3.10	470	2.90	295	4.50	2200	5.00	3130	3.50	866
6	....	....	3.90	1341	....	...	4.80	2725	5.80	5100	6.60	7460	4.30	1891	3.00	380	2.80	220	3.90	1341	4.70	2540	3.40	755
7	....	....	4.00	1471	....	...	4.60	2365	5.40	4065	6.30	6545	4.20	1745	3.00	380	2.80	220	4.90	2920	4.50	2200	3.40	755
8	....	....	4.10	1605	....	...	4.50	2200	6.20	6245	5.50	4315	4.10	1605	3.00	380	2.90	295	5.50	4315	5.40	4065	3.30	655
9	....	....	3.85	1279	3.20	560	4.60	2365	6.00	5660	5.10	3350	3.90	1341	3.00	380	2.80	220	5.00	3130	5.30	3820	3.50	866
10	....	....	3.75	1156	3.20	560	4.50	2200	5.60	4570	4.80	2725	3.80	1216	3.00	380	2.80	220	5.20	3580	4.80	2725	3.70	1095
11	....	....	....	....	3.30	655	4.50	2200	5.30	3820	4.60	2365	3.60	978	2.90	295	3.00	380	5.20	3580	4.70	2540	5.00	3130
12	....	....	....	....	3.30	655	4.50	2200	5.10	3350	4.40	2043	5.95	5518	2.90	295	3.30	655	4.90	2920	4.50	2200	5.60	4570
13	....	....	....	....	3.70	1095	4.60	2365	4.90	2920	4.20	1745	5.60	4570	2.90	295	3.20	560	4.80	2725	4.30	1891	5.40	4065
14	....	....	....	....	5.55	4443	4.60	2365	4.60	2365	4.20	1745	4.50	2200	2.90	295	3.10	470	4.70	2540	4.20	1745	5.30	3820
15	....	....	....	....	7.10	9070	4.50	2200	4.40	2043	4.20	1745	4.10	1605	2.80	220	3.00	380	4.50	2200	3.90	1341	5.20	3580
16	....	....	3.60	978	7.15	9235	4.40	2043	4.60	2365	3.90	1341	3.90	1341	2.80	220	2.90	295	4.50	2200	3.80	1216	4.80	2725
17	5.10	3350	....	....	7.55	10610	4.40	2043	4.70	2540	3.80	1216	3.80	1216	2.80	220	2.90	295	4.80	2725	3.80	1216	4.70	2540
18	4.95	3025	....	....	7.80	11530	4.30	1891	4.60	2365	3.70	1095	3.80	1216	2.80	220	2.90	295	4.70	2540	3.70	1095	4.30	1891
19	5.30	3820	....	....	7.60	10790	4.20	1745	4.60	2365	3.70	1095	3.60	978	2.80	220	3.00	380	4.50	2200	3.80	1216	4.20	1745
20	7.10	9070	....	....	7.90	11910	4.20	1745	5.50	4315	3.70	1095	3.50	866	2.80	220	3.00	380	4.40	2043	3.70	1095	4.20	1745
21	6.90	8410	....	....	7.50	10430	4.10	1605	5.60	4570	3.70	1095	3.40	755	2.90	295	3.10	470	5.00	3130	3.70	1095	4.00	1471
22	6.15	6098	....	....	7.10	9070	4.00	1471	5.30	3820	3.70	1095	3.40	755	2.80	220	3.00	380	4.90	2920	3.60	978	4.50	2200
23	5.80	5100	3.20	560	7.70	11155	3.90	1341	5.00	3130	4.40	2043	3.30	655	2.80	220	3.00	380	4.70	2540	3.70	1095	5.60	4570
24	5.25	3700	....	....	7.70	11155	6.85	8250	4.70	2540	5.10	3350	3.30	655	2.80	220	3.00	380	4.30	1891	3.70	1095	5.50	4315
25	5.20	3580	....	....	7.40	10080	7.30	9735	4.50	2200	5.00	3130	3.30	655	2.80	220	3.00	380	4.00	1471	3.60	978	5.00	3130
26	5.10	3350	....	....	7.10	9070	7.40	10080	4.40	2043	5.00	3130	3.30	655	2.80	220	2.90	295	3.80	1216	3.50	866	4.80	2725
27	4.95	3025	....	....	7.50	10430	7.70	11155	5.60	4570	4.60	2365	3.50	866	2.80	220	2.90	295	3.60	978	3.60	978	5.60	4570
28	4.55	2283	....	....	8.35	13750	7.10	9070	5.90	5375	4.30	1891	3.40	755	2.80	220	2.90	295	4.00	1471	3.70	1095	7.90	11910
29	4.50	2200	....	....	7.95	12105	6.60	7460	5.30	3820	4.10	1605	3.20	560	2.70	145	3.50	866	3.80	1216	3.80	1216	7.50	10430
30	4.40	2043	....	....	7.35	9908	6.20	6245	4.90	2920	4.20	1745	3.20	560	2.70	145	3.40	755	3.80	1216	4.00	1471	7.20	9400
31	4.20	1745	....	....	6.80	8090	....	....	4.60	2365	....	....	3.10	470	2.70	145	....	...	3.70	1095	....	....	6.80	8090

Discharge during frozen period based on discharge at Kittanning, Pa., and Susquehanna River at Binghamton, N. Y.
Discharge January 1-16, 7100 sec.-ft.; February 11-28, 681 sec.-ft.; March 1-13, 477 sec.-ft.

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1908.

Day	January Gage Ht.	January Discharge	February Gage Ht.*	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec. ft	Feet	Sec.-ft.	Feet	Sec.-ft.
1	6.40	6845	4.00	1471	5.30	3820	8.00	12300	5.10	3350	6.20	6245
2	6.10	5950	....	.....	5.40	4065	7.60	10790	6.00	5660	6.00	5660
3	5.90	5375	....	.....	5.60	4570	7.40	10080	6.50	7150	5.50	4315
4	5.70	4830	....	.....	6.40	6845	7.00	8740	6.50	7150	5.10	3350
5	5.40	4065	....	.....	6.30	6545	6.80	8090	6.30	6545	4.80	2725
6	5.10	3350	....	.....	6.30	6545	6.50	7150	6.40	6845	4.60	2365
7	4.80	2725	....	.....	6.20	6245	6.30	6545	7.20	9400	4.50	2200
8	4.60	2365	4.20	1745	6.20	6245	6.40	6845	8.10	12705	4.40	2043
9	4.50	2200	....	.....	6.00	5660	6.40	6845	7.90	11910	4.20	1745
10	4.50	2200	....	.....	5.80	5100	6.30	6545	7.60	10790	4.00	1471
11	4.40	2043	....	.....	5.40	4065	6.30	6545	7.00	8740	3.90	1341
12	5.00	3130	....	.....	5.80	5100	6.20	6245	6.40	6845	3.80	1216
13	6.30	6545	....	.....	6.20	6245	5.00	3130	6.00	5660	3.60	978
14	5.70	4830	....	.....	6.30	6545	4.90	2920	5.60	4570	3.50	866
15	5.30	3820	10.20	22045	7.80	11530	4.90	2920	5.80	5100	5.65	4700
16	5.00	3130	10.80	25105	11.20	27320	5.10	3350	6.40	6845	5.50	4315
17	4.90	2920	9.10	16985	10.00	21100	4.90	2920	6.60	7460	4.50	2200
18	4.80	2725	8.90	16100	8.90	16100	4.90	2920	6.40	6845	3.80	1216
19	4.70	2540	8.30	13540	8.50	14380	5.30	3820	6.20	6245	3.70	1095
20	4.60	2365	7.80	11530	9.50	18790	7.30	9735	6.00	5660	3.60	978
21	4.60	2365	7.40	10080	8.50	14380	6.40	6845	6.00	5660	3.50	866
22	4.50	2200	7.00	8740	8.00	12300	6.00	5660	5.60	4570	3.50	866
23	4.50	2200	6.60	7460	7.40	10080	5.90	5375	5.40	4065	3.80	1216
24	4.40	2043	6.20	6245	6.90	8410	5.80	5100	5.10	3350	6.25	6395
25	4.30	1891	5.90	5375	6.50	7150	5.70	4830	5.00	3130	5.60	4570
26	....	....	5.70	4830	7.20	9400	5.50	4315	5.20	3580	4.50	2200
27	....	....	5.60	4570	7.50	10430	5.30	3820	5.60	4570	4.00	1471
28	....	....	5.40	4065	8.60	14800	5.20	3580	5.60	4570	3.80	1216
29	....	....	5.40	4065	8.60	14800	5.10	3350	6.00	5660	3.70	1095
30	....	....	....	....	9.00	16540	5.00	3130	6.00	5660	3.70	1095
31	....	....	....	....	8.60	14800	....	....	6.20	6245	....	....

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	3.70	1095	3.50	866	3.00	380	2.70	145	2.70	145	2.70	145
2	3.60	978	3.50	866	3.00	380	2.80	220	2.70	145	2.70	145
3	3.60	978	3.50	866	2.90	295	2.80	220	2.70	145	2.70	145
4	4.80	2725	3.50	866	2.90	295	2.80	220	2.70	145	....	...
5	4.00	1471	3.40	755	2.90	295	2.70	145	2.80	220	2.70	145
6	3.80	1216	3.40	755	2.90	295	2.70	145	2.80	220	....	...
7	3.70	1095	3.40	755	2.80	220	2.70	145	2.80	220	....	...
8	3.60	978	3.40	755	2.80	220	2.70	145	2.70	145	....	...
9	3.40	755	3.40	755	2.80	220	2.70	145	2.70	145	....	...
10	3.30	655	3.30	655	2.80	220	2.70	145	2.70	145	....	...
11	3.20	560	3.30	655	2.70	145	2.70	145	2.80	220	....	...
12	3.20	560	3.30	655	2.70	145	2.70	145	2.80	220	2.70	145
13	3.10	470	3.30	655	2.70	145	2.70	145	2.80	220	....	...
14	3.10	470	3.30	655	2.70	145	2.70	145	2.90	295	....	...
15	3.00	380	3.20	560	2.70	145	2.70	145	2.80	220	....	...
16	3.00	380	3.20	560	2.70	145	2.70	145	2.80	220	....	...
17	3.00	380	4.10	1605	2.70	145	2.70	145	2.90	295	....	...
18	3.10	470	4.30	1891	2.70	145	2.70	145	2.90	295	....	...
19	3.10	470	3.90	1341	2.70	145	2.70	145	3.00	380	3.70	1095
20	3.00	380	3.40	755	2.70	145	2.70	145	3.00	380	....	...
21	3.50	866	3.30	655	2.70	145	2.70	145	3.00	380	....	...
22	3.80	1216	3.30	655	2.70	145	2.70	145	3.00	380	....	...
23	4.00	1471	3.30	655	2.70	145	2.70	145	2.90	295	....	...
24	4.80	2725	3.20	560	2.70	145	2.70	145	2.90	295	....	...
25	5.00	3130	3.20	560	2.70	145	2.70	145	2.90	295	....	...
26	5.70	4830	3.20	560	2.70	145	2.70	145	2.90	295	3.40	755
27	5.00	3130	3.10	470	2.70	145	2.70	145	2.80	220	3.60	978
28	4.50	2200	3.10	470	2.70	145	2.70	145	2.80	220	3.70	1095
29	4.10	1605	3.10	470	2.70	145	2.70	145	2.80	220	3.70	1095
30	3.80	1216	3.00	380	2.70	145	2.70	145	2.80	220	3.60	978
31	3.60	978	3.00	380	....	...	2.70	145	....	...	3.80	1216

Discharge during frozen period estimated on basis of discharge at Kittanning, Pa., and Susquehanna River drainage areas and climatological reports. Discharge Jan. 26–31, 1400 sec.-ft., Feb. 1–14, 729 sec.-ft., Dec. 4–26, 228 sec.-ft.

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.53	900	4.33	1940	7.33	9840	5.33	3890	11.91	31300	4.13	1650	3.93	1380	2.93	320	2.83	242	2.83	242	3.23	588	3.33	685
2	3.43	788	4.23	1790	7.44	10200	5.13	3420	12.50	34600	3.93	1380	3.84	1250	2.93	320	2.83	242	2.83	242	3.23	588	3.33	685
3	3.33	685	4.13	1650	6.93	8510	4.94	2980	11.38	28300	3.84	1250	3.73	1130	2.93	320	2.83	242	2.73	168	3.13	497	3.23	588
4	3.43	788	5.43	4140	6.23	6340	5.73	4910	9.86	20500	3.84	1250	3.73	1130	2.83	242	2.83	242	2.73	168	3.13	497	3.23	588
5	5.93	5460	6.13	6040	5.43	4140	5.53	4390	8.83	15800	3.93	1380	3.63	1010	2.83	242	2.83	242	2.73	168	3.13	497	3.23	588
6	8.24	13200	8.02	12400	4.94	2780	5.43	4140	7.63	10900	5.53	4390	3.63	1010	2.83	242	2.83	242	2.73	168	3.13	497	3.23	588
7	7.92	12000	7.52	10500	4.73	2600	5.73	4910	6.53	7240	5.83	5180	3.53	900	2.83	242	2.73	168	2.73	168	3.03	407	3.01	388
8	5.93	5460	6.73	7870	4.73	2600	5.92	5460	6.03	5750	5.43	4140	3.43	788	2.83	242	2.73	168	2.73	168	3.13	497	3.33	685
9	4.93	3000	5.93	5460	4.64	2420	5.44	4180	5.63	4650	5.23	3650	3.33	685	2.83	242	2.73	168	2.73	168	3.23	588	3.33	685
10	4.73	2600	5.63	4650	4.94	2980	6.13	6040	5.23	3650	5.33	3890	3.33	685	2.83	242	2.73	168	2.73	168	3.23	588	3.23	588
11	4.65	2420	5.63	4650	6.43	6940	5.53	4390	5.24	3670	5.73	4910	3.23	588	2.83	242	2.73	168	2.93	320	3.43	788	3.43	788
12	4.54	2250	5.13	3420	6.83	6640	5.33	3890	5.63	4650	5.33	3890	3.13	497	2.83	242	2.73	168	3.73	1130	3.33	685	3.43	788
13	4.43	2090	4.94	2980	5.93	5460	5.33	3890	5.43	4140	5.03	3200	3.03	407	2.83	242	2.73	168	3.53	900	3.23	588	3.53	900
14	4.54	2250	4.94	2980	5.63	4650	6.13	6040	5.33	3890	5.13	3420	3.03	407	2.83	242	2.73	168	3.13	497	3.23	588	3.73	1130
15	4.33	1940	5.43	4140	5.23	3650	6.73	7870	5.23	3650	4.94	2980	2.93	320	2.83	242	2.73	168	2.93	320	3.23	588	3.73	1130
16	4.23	1790	8.12	12800	4.94	2980	6.03	5750	5.93	5460	4.73	2600	2.93	320	2.83	242	2.73	168	2.93	320	3.23	588	3.62	1000
17	4.23	1790	7.52	10500	4.73	2600	5.53	4390	6.13	6040	4.63	2420	2.83	242	2.93	320	2.73	168	3.03	407	3.33	685	3.44	800
18	4.07	1510	6.83	8190	4.64	2420	5.43	4140	6.03	5750	4.63	2420	2.83	242	2.93	320	2.73	168	2.93	320	3.33	685	3.34	700
19	4.07	1510	7.13	9170	4.54	2250	5.33	3890	5.73	4910	4.53	2250	2.83	242	2.93	320	2.73	168	3.03	407	3.33	685	3.34	700
20	3.93	1380	7.33	9840	4.54	2250	6.03	5750	5.43	4140	4.53	2250	2.93	320	2.83	242	2.73	168	3.23	588	3.43	788	3.24	600
21	3.84	1250	6.73	7870	4.43	2090	6.43	6940	5.23	3650	4.73	2600	2.93	320	2.83	242	2.73	168	3.43	788	3.53	900	3.24	600
22	3.93	1380	6.33	6640	4.33	1940	6.13	6040	4.94	2980	5.13	3420	3.03	407	2.83	242	2.73	168	3.84	1250	3.93	1380	3.13	500
23	5.73	4910	6.73	7870	4.33	1940	5.83	5180	4.82	2780	5.13	3420	3.13	497	2.83	242	2.73	168	3.73	1130	4.53	2250	3.13	500
24	7.44	10200	8.79	15600	4.94	2980	5.63	4650	4.54	2250	5.03	3200	3.23	588	2.83	242	2.73	168	3.63	1010	4.43	2090	3.13	500
25	8.12	12800	9.63	19400	7.82	11600	5.33	3890	4.33	1940	5.03	3200	3.13	497	2.83	242	2.73	168	3.63	1010	4.43	2090	3.13	500
26	7.23	9500	8.92	16200	7.92	12000	5.43	4140	4.23	1790	4.94	2980	3.13	497	2.83	242	2.73	168	3.53	900	3.93	1380	3.13	500
27	6.73	7870	8.34	13700	6.93	8510	5.43	4140	4.07	1510	4.73	2600	3.13	497	2.83	242	2.73	168	3.53	900	3.93	1380	3.07	450
28	5.93	5460	7.82	11600	6.33	6640	5.43	4140	3.93	1380	4.63	2420	3.03	407	2.83	242	2.73	168	3.43	788	3.84	1250	3.02	400
29	5.43	4140	....	....	5.73	4910	5.33	3890	4.23	1790	4.33	1940	3.03	407	2.83	242	2.73	168	3.33	685	3.53	900	3.02	400
30	4.94	2980	....	....	5.63	4650	10.74	24800	4.23	1790	4.13	1650	3.03	407	2.83	242	2.83	242	3.33	685	3.43	788	3.02	400
31	4.54	2250	....	....	5.43	4140	....	....	4.13	1650	....	....	2.93	320	2.83	242	....	...	3.33	685	....	...	3.02	400

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1910.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec. ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	....	....	10.30	23600	5.00	3130	7.00	8740	4.50	2200
2	....	....	....	....	13.65	41000	5.00	3130	7.00	8740	4.50	2200
3	....	....	....	....	11.40	28400	5.00	3130	7.50	10400	4.50	2200
4	....	....	....	....	11.00	26200	4.80	2720	8.00	12300	4.50	2200
5	....	....	5.00	3130	10.90	25600	4.50	2200	8.00	12300	4.50	2200
6	....	....	....	....	10.30	22600	4.50	2200	7.00	8740	4.50	2200
7	....	....	....	....	10.50	23600	4.50	2200	7.00	8740	4.50	2200
8	....	....	....	....	9.50	18800	4.50	2200	7.00	8740	4.50	2200
9	....	....	....	....	9.10	17000	4.20	1750	7.00	8740	4.50	2200
10	....	....	....	....	9.00	16500	4.00	1470	6.50	7150	4.00	1470
11	....	....	....	....	9.00	16500	4.00	1470	6.50	7150	4.00	1470
12	....	....	4.50	2200	8.80	15700	4.00	1470	6.00	5660	4.00	1470
13	....	....	....	....	8.00	12300	4.10	1610	6.00	5660	4.00	1470
14	....	....	....	....	7.40	10100	4.10	1610	6.00	5660	4.00	1470
15	....	....	....	....	6.00	5660	3.80	1200	5.50	4320	4.00	1470
16	....	....	....	....	5.60	4570	3.57	945	5.50	4320	3.47	825
17	....	....	....	....	5.50	4320	3.57	945	5.00	3130	3.47	825
18	....	....	....	....	5.50	4320	3.80	1200	4.00	1470	3.47	825
19	....	....	4.50	2200	5.40	4060	3.80	1200	4.00	1470	4.00	1470
20	....	....	....	....	6.00	5660	5.00	3130	4.00	1470	4.00	1470
21	....	....	....	....	6.60	7460	6.20	6240	4.00	1470	4.00	1470
22	5.00	3130	....	....	7.00	8740	6.40	6840	4.00	1470	3.47	825
23	....	....	....	....	7.00	8740	6.60	7460	4.00	1470	3.47	825
24	....	....	....	....	7.10	9070	7.40	10100	4.50	2200	3.47	825
25	....	....	....	....	7.10	9070	8.00	12300	4.50	2200	3.47	825
26	....	....	5.00	3130	7.30	9740	9.20	17400	4.00	1470	2.93	320
27	....	....	8.10	12700	7.30	9740	9.00	16500	4.00	1470	2.93	320
28	....	....	9.10	17000	7.20	9400	8.50	14400	4.00	1470	2.93	320
29	4.50	2200	....	....	7.20	9400	8.20	13100	4.00	1470	2.93	320
30	....	....	....	....	7.00	8740	8.60	14800	4.00	1470	2.93	320
31	....	....	....	....	6.50	7150	....	....	4.50	2200	....	...

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.93	320	2.93	320	2.95	337	3.03	405	4.34	1970	5.00	3130
2	2.93	320	2.93	320	3.05	424	3.03	405	4.40	2040	4.90	2920
3	2.93	320	2.76	190	3.13	500	3.03	405	4.50	2200	4.85	2822
4	2.93	320	2.73	168	3.30	655	2.95	337	4.60	2360	4.60	2365
5	2.93	320	2.70	145	3.80	1200	2.92	306	4.55	2280	4.55	2282
6	2.93	320	2.70	145	5.50	4320	3.21	570	4.45	2120	4.40	2043
7	2.93	320	2.70	145	5.62	4620	3.80	1210	4.25	1820	4.20	1745
8	2.93	320	2.70	145	4.80	2720	3.79	1200	4.00	1470	4.10	1605
9	2.93	320	2.70	145	4.40	2040	3.58	958	3.90	1340	4.00	1471
10	2.93	320	2.93	320	4.12	1640	3.35	710	4.40	2040	4.00	1471
11	3.47	825	3.03	405	3.80	1200	3.22	580	5.70	4830	3.95	1406
12	3.47	825	3.03	405	3.57	945	3.13	500	5.50	4320	3.95	1406
13	3.47	825	2.93	320	3.48	849	2.98	362	4.60	2360	3.90	1341
14	4.00	1470	2.93	320	3.35	710	2.93	320	4.90	2920	3.90	1341
15	4.00	1470	2.87	250	3.27	622	2.93	320	4.90	2920	3.90	1341
16	4.00	1470	2.87	250	3.11	481	2.93	320	4.80	2720	3.95	1406
17	4.00	1470	2.87	250	3.08	452	2.93	320	4.75	2630	3.95	1406
18	3.47	825	2.87	250	3.03	405	2.93	320	4.60	2360	3.95	1406
19	3.47	825	2.93	320	3.03	405	2.98	362	4.65	2450	3.95	1406
20	3.47	825	2.93	320	2.98	362	2.93	320	4.50	2200	3.95	1406
21	3.47	825	2.93	320	2.93	320	2.95	337	4.45	2120	3.95	1406
22	3.47	825	2.87	250	2.93	320	2.86	264	4.40	2040	3.95	1406
23	3.47	825	2.93	320	2.87	250	3.05	405	4.70	2540	3.95	1406
24	2.97	362	3.13	500	2.94	328	3.19	550	5.35	3940	3.95	1406
25	2.97	362	3.24	600	3.26	622	3.35	710	5.50	4320	3.95	1406
26	2.93	320	3.13	500	3.35	710	3.57	945	5.65	4700	4.00	1471
27	2.93	320	3.13	500	3.43	825	3.79	1200	5.60	4570	4.20	1745
28	2.93	320	3.13	500	3.35	710	4.10	1610	5.80	5100	4.40	2043
29	2.97	362	3.13	500	3.24	600	4.34	1970	5.50	4320	4.55	2282
30	2.97	362	3.08	452	3.19	550	4.34	1970	5.30	3820	6.50	7150
31	2.97	362	2.93	320	....	...	4.25	1820	....	....	7.30	9735

Daily Gage Heights and Discharges of Allegheny River at Red House, N. Y., for 1911.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	6.40	6845	6.30	6545	4.80	2725	5.55	4440	5.20	3580	3.60	978	3.70	1095	2.94	254
2	7.10	9070	5.70	4830	4.70	2540	5.20	3580	5.25	3700	3.65	1036	3.50	866	3.04	416
3	8.80	15660	5.45	4195	4.55	2285	4.90	2920	5.40	4065	3.60	978	3.35	705	3.00	380
4	8.10	12705	5.15	3465	4.50	2200	5.05	3240	5.25	3700	3.55	922	3.20	560	3.00	380
5	7.40	10080	4.10	1605	4.25	1818	6.25	6395	4.90	2920	3.55	922	3.20	560	3.10	470
6	6.80	8090	4.10	1605	4.00	1471	6.80	8090	4.85	2820	3.60	978	3.20	560	3.35	705
7	5.70	4830	4.20	1745	4.00	1471	7.95	12105	4.75	2630	3.50	866	3.05	425	3.85	1278
8	5.40	4065	4.25	1818	4.20	1745	8.10	12705	4.50	2200	3.45	810	3.05	425	3.40	755
9	5.55	4440	4.40	2043	4.80	2725	7.70	11155	4.20	1745	3.40	755	3.25	607	3.25	607
10	6.00	5660	4.30	1891	5.00	3130	7.72	11230	4.25	1818	3.35	705	3.20	560	3.20	560
11	6.50	7150	4.30	1891	5.20	3580	6.65	7615	4.25	1818	4.20	1745	3.20	560	3.00	380
12	6.90	8410	4.00	1471	5.55	4440	6.55	7305	3.90	1341	4.85	2820	3.45	810	2.90	295
13	7.20	9400	4.05	1538	5.70	4830	6.40	6845	3.80	1216	5.55	4440	3.40	755	3.10	470
14	7.95	12105	4.10	1605	5.85	5240	6.25	6395	3.75	1155	5.70	4830	3.45	810	3.25	607
15	8.65	15015	4.85	2820	6.30	6545	6.25	6395	3.70	1095	5.30	3820	3.30	655	3.15	515
16	8.20	13120	5.10	3350	6.20	6245	6.00	5660	3.70	1095	4.85	2820	3.20	560	3.60	978
17	7.50	10430	5.90	5375	5.40	4065	5.85	5240	3.85	1278	4.30	1891	3.15	515	3.55	922
18	6.80	8090	6.20	6245	5.20	3580	5.50	4315	3.85	1278	4.10	1605	3.15	515	3.55	922
19	6.50	7150	5.75	4965	5.30	3820	5.50	4315	3.80	1216	3.35	705	3.10	470	3.45	810
20	6.15	6100	5.40	4065	5.35	3940	5.20	3580	3.95	1406	3.30	655	3.10	470	3.15	515
21	6.00	5660	4.90	2920	5.20	3580	5.85	5240	3.85	1278	3.30	655	3.00	380	3.15	515
22	5.55	4440	4.95	3025	5.20	3580	6.20	6245	3.70	1095	3.55	922	3.00	380	3.30	655
23	5.20	3580	5.00	3130	6.20	6245	5.95	5520	3.65	1036	3.50	866	3.10	470	3.33	685
24	4.00	1471	5.00	3130	5.55	4440	5.70	4830	3.85	1278	3.60	978	3.00	380	3.20	560
25	5.25	3700	5.00	3130	5.20	3580	5.55	4440	4.75	2630	3.65	1036	3.00	380	3.25	607
26	6.65	7615	4.90	2920	5.55	4440	5.20	3580	5.30	3820	3.60	978	3.00	380	3.33	685
27	6.80	8090	4.95	3025	6.20	6245	5.25	3700	4.85	2820	3.95	1406	2.90	295	3.85	1278
28	9.15	17210	4.90	2920	8.10	12705	5.05	3240	4.00	1471	4.30	1891	2.94	254	6.45	6997
29	8.20	13120	....	....	7.75	11340	4.80	2725	3.85	1278	3.80	1216	2.80	220	8.60	14800
30	7.55	10610	....	.....	6.60	7460	4.85	2820	3.80	1216	3.65	1036	2.90	295	7.00	8740
31	7.00	8740	....	.....	5.75	4965	....	.....	3.80	1216	....	.....	2.90	295	5.45	4190

Estimated Monthly Discharge of Allegheny River at Red House, N. Y.

[Drainage area, 1640 square miles.]

Month	Discharge in second-feet Maximum	Discharge in second-feet Minimum	Discharge in second-feet Mean	Run-off Second-feet per square mile	Run-off Depth in inches
1904*					
January	28068	2200	.....	.....	.....
February	24570	1279	.....	.....	.....
March	26760	2365	11201	6.820	7.610
April	13750	2764	6945	4.230	4.720
May	10430	1341	3927	2.390	2.760
June	9804	560	2131	1.300	1.450
July	5805	608	1556	0.948	1.090
August	2043	380	757	0.485	0.559
September	2633	380	909	0.556	0.620
October	3350	1072	1985	1.210	1.400
November	1341	560	815	0.511	0.513
December	12503	655	2245	4.520	5.220
1905**					
January	5265	705	2459	1.490	1.660
February	3025	1937	2177	1.330	1.480
March	29952	2090	10727	6.530	7.280
April	10973	2200	3941	2.270	2.530
May	2122	755	1241	0.755	0.870
June	9334	655	2905	1.770	1.980

Estimated Monthly Discharge of Allegheny River at Red House, N. Y.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1905**					
July	5238	617	1985	1.210	1.400
August	1229	338	640	0.390	0.450
September	1119	220	477	0.302	0.337
October	3130	160	1259	0.772	0.890
November	9735	705	2201	1.340	1.500
December	10430	866	4276	2.600	3.000
The year	29952	160	2857	1.730	23.377
1906†					
January	13330	1675	4780	2.910	3.360
February	2283	866	1242	0.756	0.790
March	13960	380	2458	1.500	1.730
April	9235	2043	5571	3.400	3.990
May	4315	1406	2801	1.710	1.970
June	2633	380	998	0.610	0.680
July	470	145	290	0.196	0.230
August	1538	295	770	0.474	0.550
September	1471	145	485	0.308	0.340
October	5660	866	2739	1.670	1.920
November	7305	1471	2863	1.740	1.940
December	15660	1471	5930	3.620	4.170
The year	15660	145	2577	1.576	21.670
1907‡					
January	9070	1745	5630	3.430	3.950
February	1818	560	1000	0.610	0.640
March	13750	560	6100	3.720	4.290
April	11155	1341	4027	2.460	2.740
May	7150	2043	3800	2.320	2.680
June	7460	1095	2706	1.650	1.840
July	5518	470	1723	1.050	1.210
August	560	145	303	0.185	0.210
September	866	145	360	0.220	0.250
October	4315	380	2156	1.320	1.520
November	4065	866	1710	1.040	1.160
December	11910	655	3294	2.010	2.320
The year	13750	145	2734	1.668	22.810
1908§					
January	6845	1100	3000	1.830	2.110
February	25105	500	5890	3.590	3.870
March	27320	3820	10320	6.280	7.240
April	12300	2920	5815	3.550	3.960
May	12705	3130	6340	3.870	4.460
June	6395	866	2400	1.460	1.630
July	4830	380	1285	0.787	0.910
August	1891	380	743	0.453	0.520
September	380	145	191	0.116	0.130
October	220	145	152	0.093	0.110
November	380	145	241	0.147	0.160
December	1216	100	357	0.218	0.250
The year	27320	100	3061	1.866	25.350

Estimated Monthly Discharge of Allegheny River at Red House, N. Y.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
January	13200	685	4080	2.490	2.870
February	19400	1650	8000	4.880	5.080
March	12000	1940	4960	3.020	3.480
April	24800	2980	5440	3.320	3.700
May	34600	1380	7500	4.570	5.270
June	5180	1250	2860	1.740	1.940
July	1380	242	593	0.362	0.420
August	320	242	257	0.157	0.180
September	242	168	185	0.113	0.130
October	1250	168	544	0.332	0.380
November	2250	407	877	0.535	0.600
December	1130	400	644	0.393	0.450
The year	34600	168	3000	1.830	24.500
1910					
March	41000	4060	13700	8.350	9.630
April	17400	945	5270	3.210	3.580
May	12300	1470	4940	3.010	3.470
June	2200	320	1350	0.823	0.920
July	1470	320	622	0.379	0.440
August	600	145	319	0.195	0.220
September	4620	250	1000	0.610	0.680
October	1970	264	710	0.433	0.479
November	5100	1340	2894	1.765	1.969
December	9735	1341	2107	1.321	1.523
10 months	41000	145	3291	2.010	22.911
1911					
January	15660	1471	8473	5.167	5.957
February	6545	1471	3117	1.900	1.979
March	12705	1471	4419	2.695	3.107
April	12705	2725	5862	3.574	3.987
May	4065	1036	1975	1.204	1.387
June	4830	705	1509	0.920	1.026
July	1095	220	523	0.319	0.368
August	14800	254	1675	1.021	1.177

*River frozen Jan. 1-23, Nov. 28–Dec. 26.
**January, February and March subject to error on account of ice.
†December discharge estimated from Kittanning, Pa.
‡Discharge during frozen period, January, February and March, estimated from Kittanning, Pa., and Binghamton, N. Y.
§Discharge during frozen period, January, February, March and December, estimated from Kittanning, Pa., and Binghamton, N. Y.

KISKIMINETAS RIVER AT AVONMORE, PA.

This station, located at the highway bridge leading to the Pennsylvania Railroad station at Avonmore, 21 miles above the mouth, was established June 11, 1907, by the U. S. Geological Survey, and has been maintained since that time by the Water Supply Commission of Pennsylvania.

A standard chain gage, 38.32 feet from marker to bottom of weight, is bolted to the downstream handrail in the first span from the right bank. The northwest corner of right masonry bridge seat is 33.267 feet above zero of gage. The initial point for soundings is the left face of downstream masonry guard fence of right bank approach to bridge. The channel is straight for 400 feet above and 300 feet below the station.

The right bank is high and rocky, while the left is low and liable to overflow. The bed of the river is soft and sandy.

The gage is read daily by Ralph Fickes. The extreme range of gage heights is from 34.9 feet, in 1859, to 1.6 feet, in 1908.

The drainage area above the station is 1,720 square miles.

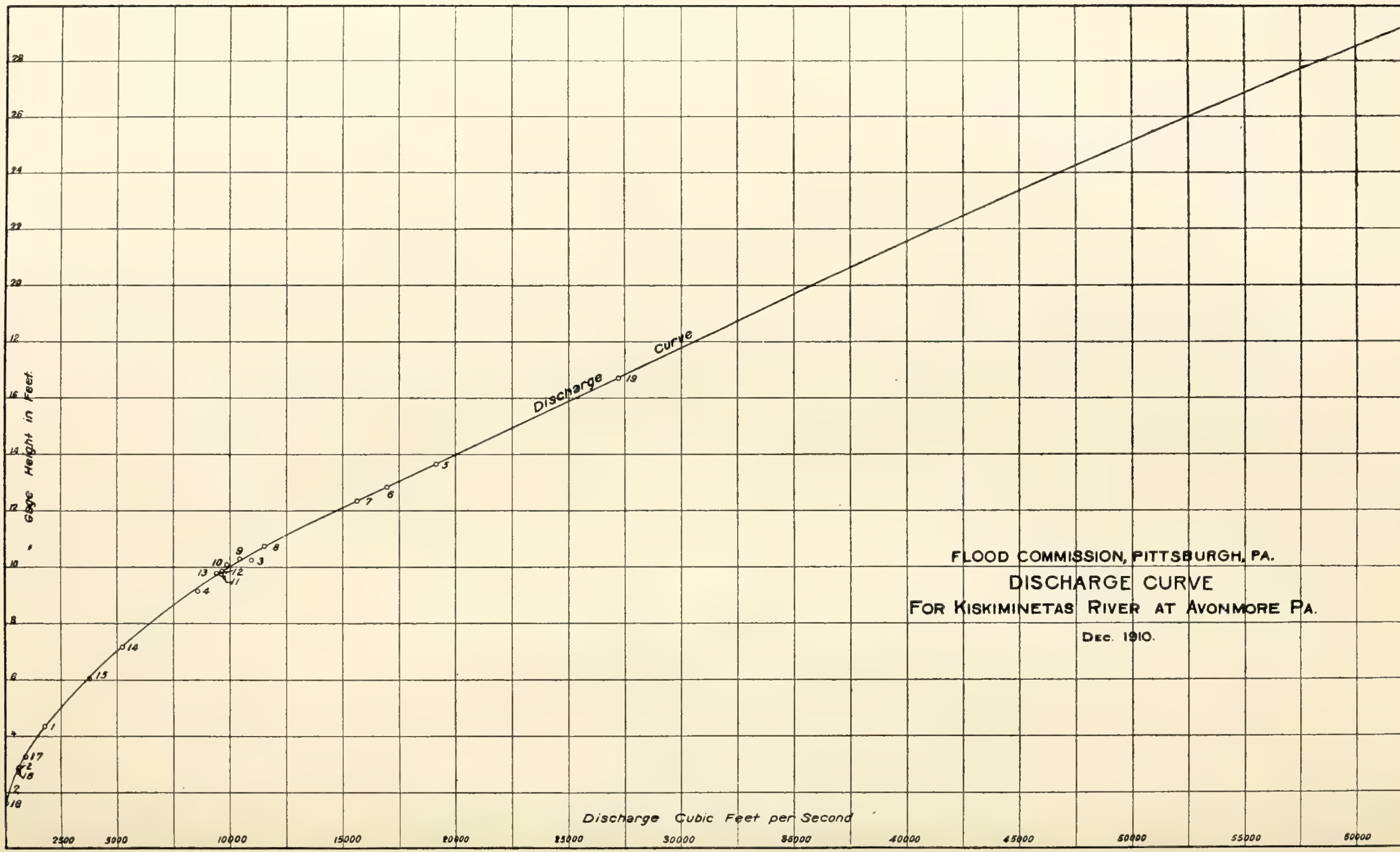
Discharge Measurements of Kiskiminetas River at Avonmore, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
1907			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
May	29	A. H. Horton	391	1100	1.62	4.36	1780
Aug.	13	do	312	434	1.46	2.89	635
Sept.	11	do	416	3550	3.10	10.26	11000
Sept.	12	do	408	3140	2.70	9.15	8600
1908							
Mar.	3	K. C. Grant	429	5280	3.65	13.64	19200
Mar.	3	do	429	4870	3.49	12.81	17000
Mar.	3	do	424	4760	3.30	12.35	15700
Mar.	4	do	422	3880	2.96	10.74	11500
Mar.	4	do	419	3710	2.83	10.32	10500
Mar.	4	do	418	3580	2.76	10.08	9880
Mar.	4	do	417	3460	2.79	9.79	9630
Mar.	5	do	417	3460	2.79	9.85	9660
Mar.	5	do	417	3460	2.78	9.79	9400
May	11	do	403	2250	2.33	7.17	5250
May	13	do	398	1810	2.06	6.06	3770
July	23	do	382	508	1.24	2.86	628
Aug.	23	R. H. Bolster	384	629	1.55	3.26	916
Sept.	25	C. E. Ryder........................	185	199	0.34	1.61	68
1910							
Mar.	2	K. C. Grant	444	6427	4.24	16.70	27224

Rating Table for Kiskiminetas River at Avonmore, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.60	65	4.30	1720	7.00	5000	9.70	9400	14.80	22240
.70	95	.40	1820	.10	5140	.80	9595	15.00	22775
.80	128	.50	1920	.20	5280	.90	9795	.50	24112
.90	163	.60	2020	.30	5425	10.00	10000	16.00	25450
2.00	200	.70	2130	.40	5570	.20	10415	.50	26775
.10	240	.80	2240	.50	5720	.40	10845	17.00	28100
.20	282	.90	2350	.60	5870	.60	11290	.50	29425
.30	326	5.00	2460	.70	6025	.80	11750	18.00	30750
.40	372	.10	2580	.80	6180	11.00	12230	.50	32050
.50	420	.20	2700	.90	6340	.20	12710	19.00	33350
.60	470	.30	2820	8.00	6500	.40	13205	.50	34650
.70	525	.40	2940	.10	6660	.60	13715	20.00	35950
.80	580	.50	3060	.20	6820	.80	14230	21.00	38625
.90	640	.60	3180	.30	6980	12.00	14750	22.00	41300
3.00	700	.70	3305	.40	7140	.20	15285	23.00	44050
.10	765	.80	3430	.50	7300	.40	15820	24.00	46800
.20	830	.90	3560	.60	7490	.60	16355	25.00	49650
.30	900	6.00	3690	.70	7650	.80	16890	26.00	52500
.40	970	.10	3820	.80	7810	13.00	17425	27.00	55500
.50	1040	.20	3950	.90	7970	.20	17960	28.00	58500
.60	1120	.30	4080	9.00	8140	.40	18495	29.00	61620
.70	1200	.40	4210	.10	8305	.60	19030	30.00	64750
.80	1280	.50	4340	.20	8475	.80	19565	31.00	67880
.90	1360	.60	4470	.30	8650	14.00	20100	....	....
4.00	1450	.70	4600	.40	8830	.20	20625	....	....
.10	1540	.80	4730	.50	9015	.40	21170	....	....
.20	1630	.90	4865	.60	9205	.60	21705	....	....

PLATE 95



FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR KISKIMINETAS RIVER AT AVONMORE PA.
DEC. 1910.
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second

Daily Gage Heights and Discharges of Kiskiminetas River at Avonmore, Pa., for 1907.

Day	June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.......	....	.....	4.60	2020	3.30	900	2.90	640	4.50	1920	3.80	1280	4.10	1540
2.......	....	.....	4.20	1630	3.20	830	2.80	580	4.00	1450	3.60	1120	4.00	1450
3.......	....	.....	4.00	1450	3.10	765	5.50	3060	3.70	1200	7.00	5000	3.90	1360
4.......	....	.....	3.70	1200	2.90	640	6.40	4210	4.30	1720	9.40	8830	3.80	1280
5.......	....	.....	3.40	970	2.80	580	6.00	3690	6.40	4210	7.70	6025	3.60	1120
6.......	....	.....	3.20	830	2.90	640	5.00	2460	5.50	3060	6.70	4600	3.30	900
7.......	....	.....	3.20	830	3.50	1040	4.30	1720	4.80	2240	9.90	9795	4.10	1540
8.......	....	.....	4.20	1630	3.30	900	3.80	1280	4.50	1920	11.00	12230	4.00	1450
9.......	....	.....	3.60	1120	3.40	970	3.60	1120	6.20	3950	8.60	7490	3.90	1360
10.......	....	.....	3.40	970	3.40	970	3.50	1040	5.40	2940	7.50	5720	4.70	2130
11.......	4.60	2020	4.20	1630	3.60	1120	8.80	7810	4.80	2240	6.40	4210	12.00	14750
12.......	8.10	6660	6.60	4470	3.10	765	9.00	8140	4.50	1920	6.00	3690	8.70	7650
13.......	7.30	5425	6.50	4340	2.90	640	6.80	4730	4.20	1630	5.40	2940	6.80	4730
14.......	13.00	17425	5.30	2820	2.70	525	5.40	2940	4.00	1450	5.00	2460	6.20	3950
15.......	10.80	11750	4.40	1820	2.60	470	4.60	2020	3.70	1200	4.90	2350	6.10	3820
16.......	8.20	6820	3.80	1280	2.50	420	4.10	1540	3.50	1040	4.50	1920	6.70	4600
17.......	6.80	4730	3.60	1120	2.60	470	3.90	1360	3.30	900	4.20	1630	6.00	3690
18.......	6.10	3820	4.50	1920	2.60	470	3.70	1200	3.20	830	4.10	1540	5.80	3430
19.......	5.30	2820	5.00	2460	2.50	420	4.10	1540	3.10	765	4.20	1630	5.40	2940
20.......	4.90	2350	4.20	1630	2.50	420	4.30	1720	3.00	700	4.90	2350	4.80	2240
21.......	4.60	2020	3.70	1200	2.50	420	4.00	1450	3.00	700	4.30	1720	4.60	2020
22.......	4.30	1720	3.40	970	2.40	372	4.60	2020	2.90	640	4.20	1630	4.80	2240
23.......	4.00	1450	3.20	830	2.60	470	4.80	2240	3.00	700	4.50	1920	6.50	4340
24.......	4.50	1920	5.80	3430	3.50	1040	5.00	2460	2.90	640	4.20	1630	17.50	29425
25.......	4.10	1540	4.20	1630	9.20	8475	4.60	2020	2.80	580	4.40	1820	11.50	13460
26.......	4.00	1450	6.00	3690	6.00	3690	4.00	1450	2.80	580	4.30	1720	9.10	8305
27.......	4.10	1540	5.80	3430	4.50	1920	3.80	1280	3.00	700	4.40	1820	8.00	6500
28.......	3.80	1280	4.20	1630	3.80	1280	3.50	1040	5.40	2940	4.50	1920	7.50	5720
29.......	3.50	1040	3.60	1120	3.50	1040	4.70	2130	6.00	3690	4.60	2020	8.30	6980
30.......	3.70	1200	3.30	900	3.30	900	5.00	2460	4.80	2240	4.20	1630	8.50	7300
31.......	....	.....	3.10	765	3.10	765	....	.....	4.20	1630	....	.....	8.00	6500

Daily Gage Heights and Discharges of Kiskiminetas River at Avonmore, Pa., for 1908.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	7.10	5140	11.20	12710	4.70	2130	8.00	6500	6.30	4080	5.60	3180	2.50	420	2.20	282	1.90	163	1.80	128	1.80	128	1.80	128
2	6.40	4210	10.90	11990	12.10	15017	7.40	5570	7.10	5140	5.30	2820	2.50	420	2.30	326	1.90	163	1.80	128	1.80	128	1.80	128
3	5.50	3060	10.60	11290	14.10	20367	7.70	6025	6.50	4340	4.60	2020	2.50	420	2.10	240	1.80	128	1.80	128	1.80	128	2.30	326
4	5.20	2700	10.80	11750	10.70	11515	6.70	4600	6.00	3690	4.20	1630	2.60	470	2.10	240	1.80	128	1.80	128	1.80	128	1.80	128
5	4.80	2240	11.20	12710	9.80	9595	6.30	4080	5.60	3180	3.90	1360	2.60	470	2.20	282	1.70	95	1.80	128	1.80	128	1.80	128
6	4.30	1720	11.20	12710	11.80	14230	8.10	6660	7.40	5570	3.70	1200	2.40	372	2.60	470	1.70	95	1.80	128	1.70	95	1.80	128
7	4.20	1630	11.20	12710	17.80	30220	6.20	3950	9.10	8305	3.50	1040	2.40	372	2.80	580	1.70	95	1.80	128	1.70	95	1.90	163
8	4.30	1720	10.90	11990	14.80	22240	5.80	3430	13.30	18227	3.20	830	2.40	372	2.70	525	1.70	95	1.80	128	1.70	95	2.90	640
9	4.70	2130	10.80	11750	13.80	19565	12.10	15017	10.20	10415	3.20	830	2.40	372	2.60	470	1.70	95	1.80	128	1.70	95	2.90	640
10	5.80	3430	10.40	10845	10.60	11290	9.50	9015	8.60	7490	3.30	900	2.30	326	2.60	470	1.70	95	1.80	128	1.70	95	3.00	700
11	6.30	4080	10.50	11065	9.90	9795	8.90	7970	7.50	5720	4.00	1450	2.20	282	2.30	326	1.70	95	1.80	128	1.70	95	2.70	525
12	7.00	5000	10.80	11750	10.20	10415	8.30	6980	6.70	4600	3.40	970	2.20	282	2.30	326	1.70	95	1.80	128	1.80	128	2.50	420
13	16.00	25450	12.80	16890	10.00	10000	7.60	5870	6.00	3690	3.20	830	2.20	282	2.10	240	b 1.70	95	1.80	128	1.80	128	2.50	420
14	12.00	14750	14.00	20100	10.80	11750	6.90	4865	5.60	3180	3.00	700	2.20	282	2.10	240	1.70	95	1.70	95	1.80	128	2.50	420
15	8.70	7650	20.30	36752	10.90	11990	6.70	4600	5.50	3060	2.90	640	2.60	470	2.10	240	1.70	95	1.70	95	2.20	282	2.30	326
16	7.80	6180	21.40	39695	13.10	17692	7.20	5280	7.90	6340	3.90	1360	2.60	470	2.00	200	1.70	95	1.70	95	2.00	200	2.20	282
17	6.90	4865	11.80	14230	9.80	9595	6.70	4600	8.80	7810	4.00	1450	2.40	372	2.00	200	1.70	95	1.70	95	2.20	282	2.30	326
18	6.20	3950	8.80	7810	10.60	11290	5.90	3560	9.00	7970	3.50	1040	2.20	282	2.10	240	1.60	65	1.70	95	2.00	200	2.80	580
19	5.80	3430	7.80	6180	a 30.10	65065	12.10	15017	7.20	5280	3.70	1200	2.20	282	2.40	372	1.60	65	1.70	95	1.80	128	7.00	5000
20	5.30	2820	6.70	4600	17.90	30425	10.20	10415	13.40	18495	3.20	830	2.20	282	2.40	372	1.60	65	1.70	95	1.80	128	5.10	2580
21	5.00	2460	6.00	3690	11.90	14490	7.10	5140	10.10	10205	3.60	1120	2.20	282	2.70	525	1.60	65	1.70	95	1.80	128	3.80	1280
22	5.70	2305	5.60	3180	9.60	9205	6.40	4210	8.20	6820	3.70	1200	3.20	830	2.60	470	1.60	65	1.70	95	b 1.80	128	3.40	970
23	6.70	4600	4.90	2350	8.90	7970	5.90	3560	7.80	6180	3.70	1200	3.10	765	3.30	900	1.60	65	1.70	95	1.90	163	3.40	970
24	6.20	3950	5.20	2700	8.20	6820	5.50	3060	6.90	4865	3.20	830	2.80	580	2.90	640	1.60	65	1.70	95	1.90	163	3.40	970
25	5.50	3060	5.40	2940	7.70	6025	5.80	3430	6.00	3690	2.90	640	5.70	3305	2.60	470	1.60	65	1.70	95	1.90	163	2.90	640
26	8.20	6820	5.20	2700	6.90	4865	5.50	3060	5.90	3560	3.00	700	4.60	2020	2.30	326	1.60	65	1.70	95	1.80	128	2.90	640
27	10.20	10415	5.60	3180	7.30	5425	5.30	2820	5.30	2820	2.80	580	3.90	1360	2.10	240	1.60	65	1.70	95	1.80	128	3.00	700
28	13.80	19565	4.80	2240	8.10	6660	5.10	2580	5.00	2460	2.70	525	3.20	830	2.00	200	1.70	95	1.70	95	1.80	128	2.80	580
29	13.50	18762	4.00	1450	8.50	7300	4.50	1920	5.50	3060	2.50	420	2.80	580	2.00	200	1.80	128	1.80	128	1.80	128	2.60	470
30	13.00	17425	....	....	10.10	10205	4.30	1720	6.60	4470	2.50	420	2.60	470	1.90	163	1.80	128	1.80	128	1.80	128	2.60	470
31	11.60	13715	....	....	8.30	6980	....	....	5.60	3180	....	...	2.40	372	1.90	163	....	...	1.80	128	....	...	2.70	525

a. Max. 4 P. M. 30.8 = 67250 sec.-ft. b. Interpolated. Ice conditions prevailed Jan. 30 to Feb. 14.

Daily Gage Heights and Discharges of Kiskiminetas River at Avonmore, Pa., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.60	470	3.70	1200	7.70	6025	5.70	3305	13.00	17425	2.85	510	3.45	1005	2.85	610	2.55	445	1.85	145	2.45	396	2.15	261
2	4.10	1540	3.60	1120	9.20	8475	5.60	3180	12.80	16890	3.80	1280	3.10	765	2.60	470	2.25	304	1.85	145	2.45	396	2.15	261
3	4.20	1630	3.80	1280	11.50	13460	5.50	3060	9.80	9595	3.25	865	2.85	610	2.35	349	2.15	261	1.85	145	2.35	359	2.15	261
4	4.10	1540	4.00	1450	13.70	19297	5.50	3060	9.80	9595	3.50	1040	2.80	580	2.20	282	2.05	220	1.85	145	2.35	359	2.05	220
5	3.60	1120	4.10	1540	11.50	13460	5.70	3305	8.70	7650	3.55	1080	2.55	445	2.05	220	2.10	240	1.90	163	2.30	326	2.05	220
6	3.70	1200	6.00	3690	8.80	7810	5.60	3180	7.80	6180	6.05	3755	2.45	396	2.05	220	2.05	220	1.85	145	2.25	304	2.05	220
7	5.10	2580	6.50	4340	8.00	6500	10.40	10845	7.10	5140	5.60	3180	2.50	420	2.00	200	2.05	220	1.75	111	2.25	304	2.05	220
8	4.00	1450	5.60	3180	7.50	5720	8.80	7810	6.30	4080	4.45	1870	2.35	349	1.95	182	2.05	220	1.75	111	2.25	304	2.25	304
9	3.50	1040	4.50	1920	7.50	5720	7.50	5720	5.80	3430	4.30	1720	2.40	372	2.00	200	1.95	182	1.75	111	2.25	304	2.55	450
10	3.50	1040	5.50	3060	8.50	7300	6.90	4865	4.70	2130	5.45	3000	2.25	304	1.85	145	2.00	200	1.80	128	2.40	372	2.55	450
11	3.50	1040	6.10	3820	8.50	7300	6.20	3950	5.40	2940	11.95	14620	2.15	261	1.85	145	1.95	182	1.85	145	2.45	396	2.75	555
12	3.70	1200	5.30	2820	7.30	5425	5.80	3430	5.20	2700	9.00	8140	2.20	282	1.90	163	1.95	182	2.15	261	2.45	396	2.75	555
13	3.60	1120	5.50	3060	6.60	4470	5.60	3180	4.70	2130	6.95	4930	2.15	261	1.85	145	1.95	182	4.15	1585	2.35	359	2.95	670
14	3.60	1120	6.50	4340	6.30	4080	10.50	11065	4.40	1820	6.50	4340	2.20	282	1.90	163	1.95	182	3.15	795	2.35	359	4.95	2405
15	4.70	2130	7.80	6180	5.80	3430	12.20	15285	4.10	1540	5.65	3240	2.25	304	2.05	220	1.90	163	2.60	420	2.20	282	6.15	3885
16	7.80	6180	8.90	7970	5.40	2940	9.30	8650	4.10	1540	4.95	2405	2.25	304	3.70	1200	2.05	220	2.55	445	2.25	304	5.25	2760
17	6.20	3950	11.10	12230	5.10	2580	7.90	6340	3.80	1280	4.50	1920	2.30	326	3.70	1200	1.85	145	2.35	359	2.25	304	6.75	4665
18	7.60	5870	7.20	5280	4.90	2350	7.00	5000	3.70	1200	4.45	1870	2.15	261	3.65	1160	2.05	220	2.15	261	2.25	304	6.05	3755
19	7.00	5000	6.90	4865	4.60	2020	6.30	4080	3.50	1040	4.40	1820	2.10	240	3.10	765	1.95	182	2.15	261	2.25	304	5.95	3625
20	5.40	2940	7.10	5140	5.60	3180	5.80	3430	3.30	900	4.35	1770	2.05	220	2.85	610	1.90	163	2.30	326	2.30	326	5.45	3000
21	5.00	2460	7.60	5870	6.20	3950	8.10	6660	3.50	1040	3.55	1080	2.05	220	2.65	500	1.85	145	2.45	396	2.25	304	5.45	3000
22	4.90	2350	6.90	4865	5.50	3060	11.50	13460	4.60	2020	3.50	1040	2.00	200	2.60	470	1.85	145	2.45	396	2.25	304	5.45	3000
23	4.80	2240	6.90	4865	5.10	2580	11.20	12710	4.30	1760	3.25	865	2.25	304	2.35	349	1.75	111	2.45	396	2.25	304	5.45	3000
24	8.50	7300	15.70	24670	4.70	2130	9.50	9015	3.40	970	3.60	1120	3.90	1360	2.30	326	2.15	261	3.45	1005	2.25	304	5.55	3120
25	8.20	6820	14.10	20367	5.10	2580	8.60	7490	3.20	880	3.25	865	3.15	790	2.15	261	2.10	240	5.20	2700	2.50	420	5.55	3120
26	7.60	5870	10.80	11750	8.00	6500	8.40	7140	3.10	765	3.05	732	2.75	555	2.15	261	2.35	359	3.95	1390	2.45	396	5.55	3120
27	5.70	3305	9.20	8475	7.50	5720	8.10	6660	3.10	765	3.10	765	2.60	470	2.20	282	2.15	261	3.45	1005	2.35	359	5.55	3120
28	5.20	2700	8.50	7300	7.30	5425	7.60	5870	3.20	830	4.55	1970	2.35	349	2.15	261	2.05	220	3.05	730	2.35	359	5.55	3120
29	4.70	2130	....	....	6.90	4865	7.60	5870	3.60	1120	4.10	1540	2.30	326	2.20	282	1.95	182	2.85	610	2.25	304	5.35	2880
30	4.50	1920	....	....	5.20	2700	11.00	12230	3.30	900	3.95	1400	2.15	261	2.05	220	1.90	163	2.65	495	2.30	326	5.05	2520
31	4.20	1630	....	....	5.10	2580	....	....	3.10	765	....	....	2.40	372	2.30	326	....	...	2.60	470	....	...	5.05	2520

Daily Gage Heights and Discharges of Kiskiminetas River at Avonmore, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft*	*Feet*	*Sec.-ft.*
1	5.05	2500	5.35	2880	18.25	31400	3.58	1104	5.75	3417	4.48	1900	3.40	970	2.00	200	1.85	145	2.44	391	2.18	273	4.20	1630
2	5.25	2760	4.85	2295	16.38	26457	3.45	1005	5.08	2556	4.82	2262	3.22	844	2.00	200	1.88	156	2.30	326	2.15	261	3.22	844
3	8.35	7060	5.05	2520	15.10	23042	3.38	956	4.72	2155	5.02	2484	3.10	765	1.95	181	2.00	200	2.18	273	2.15	261	3.20	830
4	11.45	13335	5.95	3625	12.78	16810	3.28	886	4.70	2130	4.82	2262	2.98	688	1.95	181	3.76	1253	2.11	244	2.15	261	3.42	984
5	7.35	5500	5.55	3120	11.45	13335	3.30	900	4.52	1940	4.45	1870	3.02	713	1.92	170	5.55	3120	2.08	232	2.18	273	3.41	977
6	9.45	5645	5.05	2520	11.38	13155	3.38	956	4.08	1522	4.95	2405	2.82	592	1.90	163	3.69	1191	2.03	212	2.20	282	4.08	1522
7	11.45	13335	6.75	4665	12.20	15285	3.25	865	3.82	1296	5.91	3573	2.82	592	1.90	163	4.40	1820	2.06	224	2.15	261	4.68	2108
8	9.05	8225	6.85	4795	10.00	10000	3.15	795	3.70	1200	5.05	2520	3.44	1006	1.90	163	3.72	1217	2.05	220	2.15	261	4.35	1770
9	7.15	5210	7.45	5645	8.38	7108	3.10	765	3.68	1184	4.52	1940	3.20	830	1.90	163	3.22	844	2.02	208	2.10	240	4.02	1468
10	6.25	4015	6.35	4145	7.28	5396	2.97	682	3.78	1270	5.10	2580	2.95	670	1.95	181	2.98	688	2.00	200	2.10	240	3.50	1040
11	8.25	6900	7.85	6260	6.52	4366	2.92	656	3.75	1244	6.85	4797	2.74	549	2.10	240	2.75	553	2.00	200	2.15	261	4.08	1522
12	10.95	12120	7.45	5645	6.00	3690	2.78	569	4.80	2240	6.92	4892	2.65	497	2.40	372	2.90	640	1.98	193	2.16	265	4.00	1450
13	11.95	14620	7.05	5070	5.70	3305	2.72	536	4.78	2218	6.21	3963	2.74	549	2.30	326	3.15	733	1.95	181	2.20	282	3.85	1322
14	11.45	13335	7.35	5500	5.55	3120	2.75	552	4.18	1612	5.65	3202	2.88	624	2.20	282	4.35	1770	1.95	181	2.16	265	3.88	1344
15	11.75	14100	7.45	5645	4.95	2405	2.65	497	3.92	1378	5.12	2604	2.71	530	2.01	204	3.70	1200	1.95	181	2.20	282	3.80	1280
16	11.45	13335	10.75	11630	4.68	2108	2.68	514	3.71	1208	5.11	2592	2.56	450	1.98	193	3.00	700	1.96	185	2.22	291	3.70	1200
17	10.75	11635	a23.50	45425	5.02	2484	2.85	610	3.50	1040	4.98	2438	6.35	4145	1.92	170	2.75	552	1.95	181	2.32	335	3.72	1217
18	13.75	19430	20.95	38510	5.00	2460	3.30	900	3.58	1104	5.31	2832	4.15	1585	1.90	163	2.65	498	1.95	181	2.30	326	3.66	1168
19	19.95	35820	16.45	26643	4.72	2155	5.68	3280	3.70	1200	c10.40	10845	3.92	1378	1.92	170	2.42	382	1.95	181	2.30	326	3.79	1271
20	11.55	13587	15.25	23443	4.80	2240	5.60	3180	3.64	1152	7.82	6202	3.18	817	1.98	193	2.35	349	1.92	170	2.40	372	4.09	1531
21	8.55	7380	17.75	30087	5.15	2640	6.38	4184	3.94	1396	6.65	4535	2.80	580	2.60	470	2.28	317	1.92	170	2.31	331	4.55	1970
22	17.15	28762	18.95	33320	5.35	2880	6.58	4444	5.08	2556	5.30	2820	2.58	460	2.22	291	2.22	291	2.01	204	2.25	304	4.48	1900
23	10.65	11400	11.05	12350	5.05	2520	6.08	3794	4.65	2075	4.80	2240	2.44	391	2.06	224	2.18	273	2.35	349	2.30	326	4.38	1800
24	8.75	7730	8.35	7060	4.88	2328	5.68	3280	4.48	1900	4.25	1675	2.40	372	2.01	204	2.26	308	2.74	497	2.40	372	5.82	3456
25	7.45	5645	7.25	5350	4.72	2155	b9.95	9897	4.90	2350	3.85	1320	2.28	317	1.95	181	2.55	445	2.40	372	2.40	372	7.00	5000
26	6.35	4145	6.65	4535	4.55	1970	11.40	13205	6.01	3703	3.65	1160	2.22	291	2.00	200	2.48	408	2.26	308	2.60	470	5.70	3305
27	8.05	6580	7.95	6420	4.25	1675	8.88	7934	5.31	2832	3.40	970	2.15	261	1.95	181	2.44	391	2.25	304	2.76	558	5.33	2856
28	8.15	6740	17.50	29425	4.05	1585	7.60	5870	4.74	2174	3.36	942	2.14	257	1.90	163	2.35	349	2.25	304	2.82	592	5.05	2520
29	7.05	5070	....	....	3.85	1320	6.62	4496	4.45	1870	4.95	2405	2.10	240	1.90	163	2.80	580	2.21	286	4.02	1468	9.64	9283
30	6.15	3855	....	....	3.78	1270	6.18	3924	4.12	1558	4.14	1576	2.08	232	1.85	145	2.70	525	2.20	282	4.32	1740	13.90	19832
31	5.85	3495	....	....	3.72	1217	....	....	4.05	1495	....	....	2.00	200	1.89	159	....	...	2.15	261	....	....	9.60	9205

a. Max. 11:30 A. M., 23.65 = 45837 sec.-ft.
b. Max. 4:45 P. M., 12.15 = 15151 sec.-ft.
c. Max. 8 P. M., 13.51 = 18762 sec.-ft.

Daily Gage Heights and Discharges of Kiskiminetas River at Avonmore, Pa., for 1911.

Day	January		February		March		April		May		June		July		August		September		October	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	8.03	6548	8.44	7204	6.49	4327	5.97	3651	5.52	3084	3.32	914	3.10	765	1.92	170	7.25	5352	7.60	5870
2	8.69	7634	7.56	5810	6.09	3807	5.62	3205	6.06	3768	3.00	700	2.82	592	1.90	163	5.40	2940	b11.05	12350
3	10.20	10415	6.74	4652	5.69	3293	5.74	3350	5.79	3418	2.86	616	2.68	514	2.12	248	3.74	1232	8.75	7730
4	9.33	8704	6.51	4353	5.44	2988	5.94	3612	5.12	2604	2.74	547	2.55	455	2.08	232	3.65	1160	7.68	5994
5	7.28	5396	6.56	4418	5.08	2456	8.62	7522	4.75	2185	2.73	542	2.42	382	2.09	236	3.29	893	7.00	5000
6	9.58	9167	5.96	3638	5.26	2772	14.05	20233	4.45	1870	5.60	3180	2.38	363	2.42	382	3.65	1160	5.95	3625
7	10.08	10164	5.31	2832	5.52	3084	12.40	15820	4.30	1720	5.54	3108	2.38	363	2.28	317	4.44	1860	8.95	8052
8	6.23	3989	5.34	2868	4.92	2377	10.52	11110	4.06	1504	4.59	2009	2.72	536	2.05	220	3.82	1296	9.08	8222
9	5.93	3599	5.26	2772	5.42	2964	9.67	7602	3.94	1396	3.99	1441	2.60	470	1.95	181	4.12	1558	8.01	6516
10	5.73	3342	5.01	2472	5.14	2628	9.44	8904	3.90	1360	3.54	1072	2.62	481	1.90	163	6.10	3820	6.10	3820
11	8.06	6596	4.52	1940	6.79	4717	8.37	7092	4.00	1450	3.21	837	2.34	344	1.85	145	5.30	2820	6.14	3872
12	7.08	5112	4.31	1730	6.62	4496	7.46	5660	3.78	1264	3.61	1128	2.50	420	1.85	145	5.30	2820	6.08	3794
13	12.81	16917	4.81	2251	7.32	5454	6.77	4691	3.55	1080	4.25	1675	2.60	470	1.85	145	4.30	1720	5.60	3180
14	14.88	22454	5.06	2532	7.36	5512	6.64	4522	3.38	956	4.00	1450	2.85	610	1.82	135	3.71	1208	5.02	2484
15	15.83	24995	8.81	7826	7.08	5112	8.40	7140	3.25	865	3.69	1192	2.90	640	1.85	145	a14.05	20234	8.40	7140
16	11.93	14568	8.36	7076	6.24	4002	7.67	5978	3.16	804	3.34	928	2.45	396	1.90	163	16.80	27570	8.38	7108
17	9.02	8173	7.18	5252	5.54	3108	6.94	4919	3.10	765	3.13	785	2.31	331	1.90	163	10.55	11178	7.40	5570
18	7.46	5660	7.86	6276	6.04	3742	6.37	4171	3.02	713	3.14	791	2.22	291	2.05	220	8.20	6820	10.46	10977
19	6.64	4522	9.20	8475	6.16	3898	5.87	3521	2.88	628	3.19	824	2.15	261	2.00	200	6.70	4600	9.20	8475
20	5.98	3644	8.31	6996	7.64	5932	6.54	3108	2.85	610	3.44	998	2.12	248	1.90	163	6.20	3950	7.56	5810
21	5.70	3305	7.36	5512	7.72	6056	7.64	5932	3.00	700	3.04	726	2.15	261	1.92	170	5.38	2916	6.62	4496
22	6.18	3924	6.36	4158	6.56	4418	7.34	5483	3.28	886	2.74	547	2.20	282	1.88	156	6.62	4496	6.01	3703
23	5.58	3156	5.98	3664	6.49	4327	8.53	7348	2.70	525	2.55	445	2.45	396	1.88	156	6.18	3924	5.78	3405
24	4.73	2163	5.71	3317	6.24	4002	8.46	7236	2.60	470	2.46	401	2.30	326	1.90	163	4.98	2438	5.72	3330
25	4.32	1740	5.52	3084	5.64	3230	7.32	5454	3.10	765	2.47	405	2.32	335	1.98	193	4.48	1900	5.28	2796
26	4.80	2240	6.24	4002	5.26	2772	6.64	4522	2.95	670	4.26	1684	2.30	326	2.32	335	4.35	1770	4.58	2000
27	6.06	3768	7.28	5396	5.54	3108	6.02	3716	2.70	525	4.39	1810	2.22	291	2.55	455	4.34	1760	4.34	1760
28	8.66	7586	7.51	5735	6.32	4106	5.54	3108	2.65	492	4.14	1576	2.10	240	2.80	580	5.80	3430	4.22	1648
29	8.78	7778	....	....	5.69	3293	5.26	2772	2.55	445	4.31	1730	2.05	220	4.15	1585	6.05	3755	4.05	1495
30	13.76	19458	....	....	5.72	3330	5.47	3024	3.45	1005	3.62	1136	1.98	193	8.24	6884	9.28	8615	3.90	1360
31	10.93	12062	....	....	6.19	3937	....	....	3.52	1056	....	....	1.95	181	6.68	4574	....	....	3.85	1320

a. Max. 9 P. M., 19.50 = 34650 sec.-ft. b. Max. 11 A. M., 11.35 = 13080 sec.-ft.

Estimated Monthly Discharge of Kiskiminetas River at Avonmore, Pa.

[Drainage area, 1720 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
June 11-31	17425	1040	3949	2.296	1.704
July	4470	765	1798	1.045	1.204
August	3475	372	1107	0.648	0.747
September	8140	580	2307	1.341	1.496
October	4210	580	1687	0.980	1.130
November	12230	1120	3488	2.028	2.262
December	29425	900	5120	2.977	3.432
1908					
January	25450	1630	6781	3.942	4.544
February	39695	1450	10826	6.294	6.788
March	67250	2130	13877	8.068	9.301
April	15017	1720	5516	3.207	3.578
May	18227	2460	6061	3.524	4.063
June	3180	420	1131	0.657	0.757
July	3305	282	659	0.383	0.441
August	900	163	353	0.205	0.236
September	163	65	93	0.053	0.059
October	128	95	112	0.064	0.074
November	282	95	139	0.080	0.089
December	5000	128	716	0.416	0.480
The year	67250	65	3855	2.241	30.410
1909					
January	7300	470	2674	1.554	1.792
February	24670	1120	5952	3.460	3.603
March	19297	2020	5601	3.256	3.754
April	15285	3060	6661	3.873	4.321
May	17425	765	3579	2.080	2.398
June	14620	510	2491	1.448	1.616
July	1360	200	426	0.248	0.286
August	1200	145	393	0.228	0.263
September	445	111	214	0.124	0.138
October	2700	111	509	0.296	0.341
November	396	282	338	0.191	0.213
December	4665	220	1976	1.149	1.324
The year	24670	111	2568	1.492	20.049
1910					
January	35820	2500	10105	5.875	6.773
February	45837	2295	12090	7.028	7.310
March	31400	1217	6835	3.979	4.587
April	15151	514	2708	1.574	1.756
May	3703	1040	1838	1.068	1.231
June	10625	942	2927	1.702	1.899
July	4145	200	722	0.420	0.484
August	470	145	208	0.121	0.139
September	3120	145	726	0.424	0.471
October	497	170	242	0.141	0.163
November	1740	240	405	0.235	0.262
December	19832	830	2826	1.642	1.893
The year	45837	145	3469	2.017	26.968
1911					
January	24995	1740	8026	4.666	5.379
February	8475	1730	4866	2.829	2.946
March	6056	2456	3682	2.141	2.468
April	20233	2772	6147	3.574	3.987
May	3768	445	1271	0.739	0.852
June	3180	401	1173	0.678	0.756
July	765	181	387	0.225	0.259
August	6884	135	619	0.359	0.414
September	34650	893	4640	2.698	3.010
October	13080	1320	4932	2.867	3.305

LOYALHANNA CREEK AT NEW ALEXANDRIA, PA.

This station, situated at the steel highway bridge, about 2 miles below New Alexandria, Westmoreland County, Pa., was established October 7, 1910, by H. P. Drake, for the Flood Commission.

A chain gage, measuring 24.08 feet from marker to bottom of weight, was originally installed at this station. On November 28, 1910, a new gage was installed to replace the original one, which had been stolen. The length of chain from marker to bottom of weight is 24.19 feet. The elevation of zero of the gage is 909.34.

The bridge seat, west side of north abutment, has an elevation of 932.89. The top of downstream handrail, 98 feet from the left bank, and 4.5 feet to the left of the second lateral strut from the right bank, is 28.01 feet above the surface of water when the gage reads zero.

The channel is straight for about 100 feet above and 1,000 feet below the station. The bed of the creek at this point is, for the most part, solid rock, and is permanent. The right bank is high and does not overflow. The left bank will overflow at a gage height of about 10 feet. The range of gage heights is about 12 feet.

The gage is read once daily by Frank Hollis.

The drainage area above the station is 256 square miles.

Discharge Measurements of Loyalhanna Creek at New Alexandria, Pa.

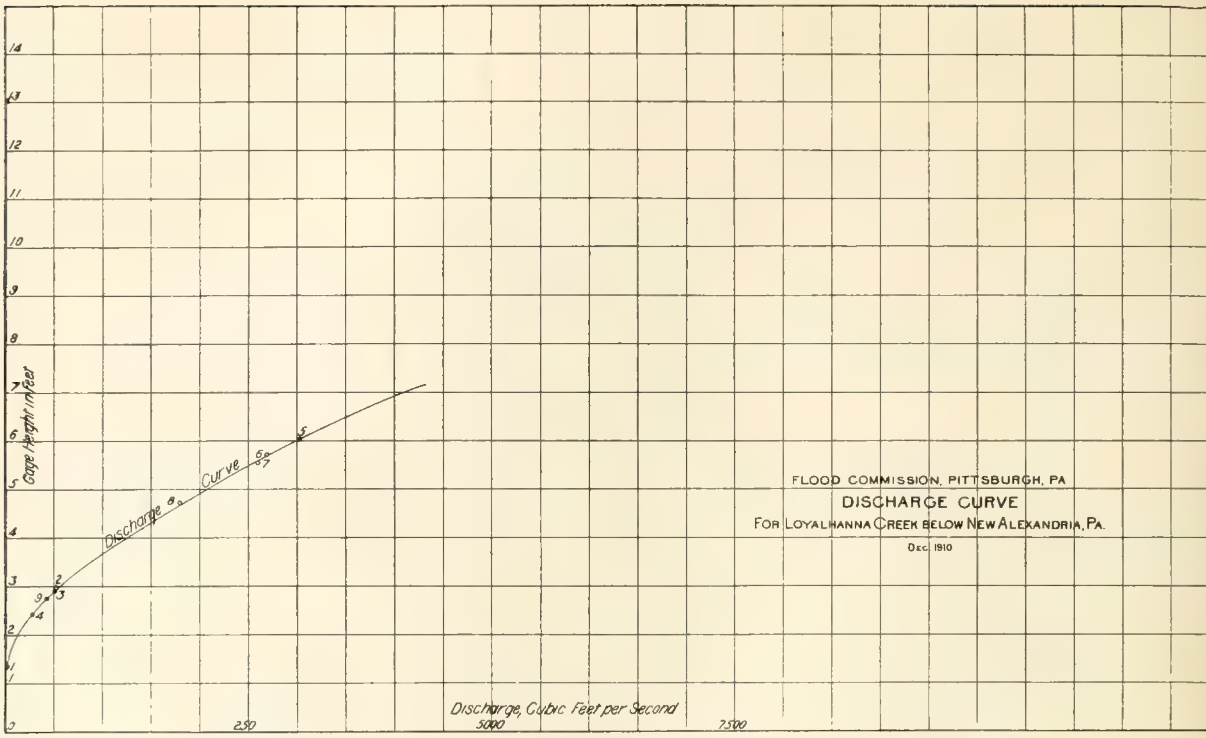
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Oct.	6a	H. P. Drake	27	17	1.00	1.38	17
Nov.	29	do	120	366	1.44	3.00	527
Nov.	29	J. T. Sykes	120	357	1.43	2.92	509
Nov.	30	H. P. Drake	110	295	0.92	2.45	272
Dec.	30	J. T. Sykes	146	772	3.90	6.03	3011
Dec.	30	do	146	727	3.72	5.71	2702
Dec.	30	do	144	690	3.78	5.53	2612
1911							
Jan.	17	do	136	585	3.07	4.74	1798
Mar.	3	H. P. Drake	119	352	1.19	2.74	418

a. Wading measurement.

Rating Table for Loyalhanna Creek at New Alexandria, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.30	15	2.50	290	3.70	1015	4.90	1985	6.10	3100
.40	20	.60	335	.80	1090	5.00	2070	.20	3200
.50	25	.70	385	.90	1170	.10	2155	.30	3305
.60	40	.80	435	4.00	1250	.20	2245	.40	3410
.70	60	.90	490	.10	1330	.30	2335	.50	3520
.80	80	3.00	545	.20	1410	.40	2425	.60	3635
.90	100	.10	605	.30	1490	.50	2515	.70	3750
2.00	125	.20	665	.40	1570	.60	2610	.80	3865
.10	155	.30	730	.50	1650	.70	2705	.90	3980
.20	185	.40	800	.60	1730	.80	2800	7.00	4100
.30	220	.50	870	.70	1815	.90	2900	....	....
.40	255	.60	940	.80	1900	6.00	3000	....	....

PLATE 96



Daily Gage Heights and Discharges of Loyalhanna Creek at New Alexandria, Pa., for 1910.

Day	October		November		December		Day	October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge		Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.......	....	....	1.46	23	2.10	155	17.......	1.38	19	1.75	70	1.79	78
2.......	....	....	1.46	23	2.00	125	18.......	1.38	19	1.75	70	1.79	78
3.......	....	....	1.46	23	2.00	125	19.......	1.38	19	1.75	70	1.79	78
4.......	....	....	1.46	23	2.00	125	20.......	1.38	19	1.85	90	1.79	78
5.......	....	....	1.46	23	2.00	125	21.......	1.36	18	1.85	90	1.79	78
6.......	....	....	1.46	23	2.10	155	22.......	1.36	18	1.80	80	1.79	78
7.......	1.38	19	1.56	28	1.70	60	23.......	2.16	173	1.65	50	1.89	98
8.......	1.38	19	1.56	28	1.69	58	24.......	2.16	173	1.65	50	1.89	98
9.......	1.38	19	1.66	52	1.69	58	25.......	1.66	52	1.95	112	1.89	98
10.......	1.38	19	1.76	72	1.79	78	26.......	1.66	52	2.05	140	1.99	123
11.......	1.38	19	1.75	70	1.79	78	27.......	1.56	28	2.05	140	1.99	123
12.......	1.38	19	1.75	70	1.79	78	28.......	1.66	52	2.15	170	2.29	217
13.......	1.38	19	1.75	70	1.79	78	29.......	1.66	52	3.00	545	6.49	3419
14.......	1.38	19	1.75	70	1.79	78	30.......	1.66	52	2.45	272	5.99	2900
15.......	1.38	19	1.85	90	1.89	98	31.......	1.46	23	....	....	3.89	1090
16.......	1.38	19	1.85	90	1.89	98							

Daily Gage Heights and Discharges of Loyalhanna Creek at New Alexandria, Pa., for 1911.

Day	January		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1......	2.88	479	2.80	435	2.70	385	2.70	385	2.00	125	2.10	155	1.40	20
2......	2.88	479	a2.80	435	2.70	385	3.20	665	2.00	125	2.10	155	1.50	25
3......	2.78	425	2.70	385	2.60	335	2.80	435	1.90	100	1.80	80	1.70	60
4......	2.78	425	2.70	385	2.70	385	2.60	335	1.70	60	1.80	80	1.60	40
5......	2.78	425	2.50	290	4.20	1410	2.60	335	1.90	100	1.80	80	1.80	80
6......	2.68	375	2.60	335	4.70	1815	2.40	255	2.50	290	1.70	60	1.50	25
7......	2.68	375	2.90	490	4.40	1570	2.40	255	2.40	255	1.60	40	1.50	25
8......	2.68	375	2.60	335	4.10	1330	2.30	220	2.20	185	2.20	185	1.50	25
9......	2.68	375	2.80	435	4.20	1410	2.30	220	2.10	155	1.80	80	1.40	20
10......	2.78	425	2.90	495	4.00	1250	2.30	220	2.10	155	1.60	40	1.30	15
11......	2.78	425	3.10	605	3.70	1015	2.70	385	2.00	125	1.60	40	1.40	20
12......	2.88	479	3.10	605	3.30	730	2.40	255	2.30	220	1.90	100	1.30	15
13......	2.88	479	3.00	545	3.10	605	2.20	185	2.00	125	3.50	870	1.30	15
14......	2.98	535	3.00	545	2.90	490	2.20	185	2.00	125	2.30	220	1.50	25
15......	5.98	2980	2.90	490	3.50	870	2.10	155	2.00	125	2.30	220	1.60	40
16......	3.98	1234	2.70	385	3.10	605	2.10	155	1.90	100	1.90	100	1.60	40
17......	a3.58	926	2.50	290	2.90	490	2.10	155	1.90	100	1.80	80	1.60	40
18......	a3.28	716	2.80	435	2.80	435	2.10	155	2.00	125	1.80	80	1.60	40
19......	a2.98	535	2.70	385	2.70	385	2.00	125	2.00	125	1.70	60	1.60	40
20......	a2.78	425	3.50	870	2.90	490	2.00	125	1.90	100	1.60	40	1.50	25
21......	a2.58	326	3.10	605	3.10	605	2.20	185	1.70	60	1.60	40	1.50	25
22......	a2.38	213	2.80	435	3.70	1015	2.10	155	1.70	60	1.70	60	1.40	20
23......	a2.18	179	3.00	545	4.00	1250	1.90	100	1.60	40	2.00	125	1.30	15
24......	1.98	120	2.70	385	3.40	800	2.00	125	1.60	40	1.90	100	1.30	15
25......	3.08	593	2.60	335	3.20	665	2.00	125	1.60	40	2.00	125	1.50	25
26......	3.08	593	2.50	290	3.00	545	2.00	125	3.50	870	1.90	100	1.70	60
27......	3.08	593	2.70	385	2.80	435	1.90	100	3.40	800	1.60	40	2.10	155
28......	3.18	653	2.50	290	2.60	335	1.80	80	3.00	545	1.60	40	1.70	60
29......	3.18	653	2.50	290	2.60	335	1.80	80	2.70	385	1.50	25	2.20	185
30......	3.18	653	2.60	335	2.90	490	2.10	155	2.30	220	1.50	25	3.30	730
31......	1.76	72	2.80	435	....	....	2.00	125	....	....	1.40	20	3.00	545

a. Estimated.
Note.—No gage readings during February.

Estimated Monthly Discharge of Loyalhanna Creek at New Alexandria, Pa.

[Drainage area, 256 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
October 7-31	173	18	38	0.148	0.171
November	545	23	91	0.356	0.397
December	3419	58	329	1.285	1.481
1911					
January	2980	72	567	2.214	2.552
March	870	290	436	1.703	1.963
April	1815	335	762	2.977	3.322
May	665	80	212	0.828	0.955
June	870	40	163	0.637	0.710
July	870	20	112	0.438	0.505
August	730	15	79	0.309	0.356

BLACK LICK CREEK AT BLACK LICK, PA.

This station, situated on the steel highway bridge, ¼ mile from the railroad station at Black Lick, Indiana Co., Pa., was established August 16, 1904, by the U. S. Geological Survey, discontinued July 15, 1906, and reëstablished January 8, 1907, by the Water Supply Commission of Pennsylvania. It is located 10 miles above the junction of Black Lick Creek and the Kiskiminetas River and one mile below Two Lick Creek.

A standard chain gage, measuring 20.16 feet from marker to bottom of weight, is attached to the upstream handrail of the bridge. The upper edge of horizontal cross-plate at elevation of guard rail on upstream side of bridge, 4.3 feet from initial point for soundings, is 14.43 feet above zero of gage. A bench mark on the heads of four spikes driven into the root of a large maple tree on the left bank, 45 feet from the edge of low water and about 190 feet upstream from the bridge, is 12.96 feet above zero of gage

Measurements are taken from upstream side of bridge at ordinary stages, from coal tipple ¼ mile above bridge at extreme high stages and by wading above bridge at lowest stages. The initial point for soundings is the first angle post on upstream hand rail, at left bank.

The channel is straight for a distance of 2,000 feet above and 250 feet below the station. The bed is of gravel, sand and boulders, and is fairly permanent. The right bank is not subject to overflow, but the left bank overflows at a gage height of 11.5 feet. The greatest range of gage heights is about 13 feet.

The gage is read twice daily by D. J. Walling.

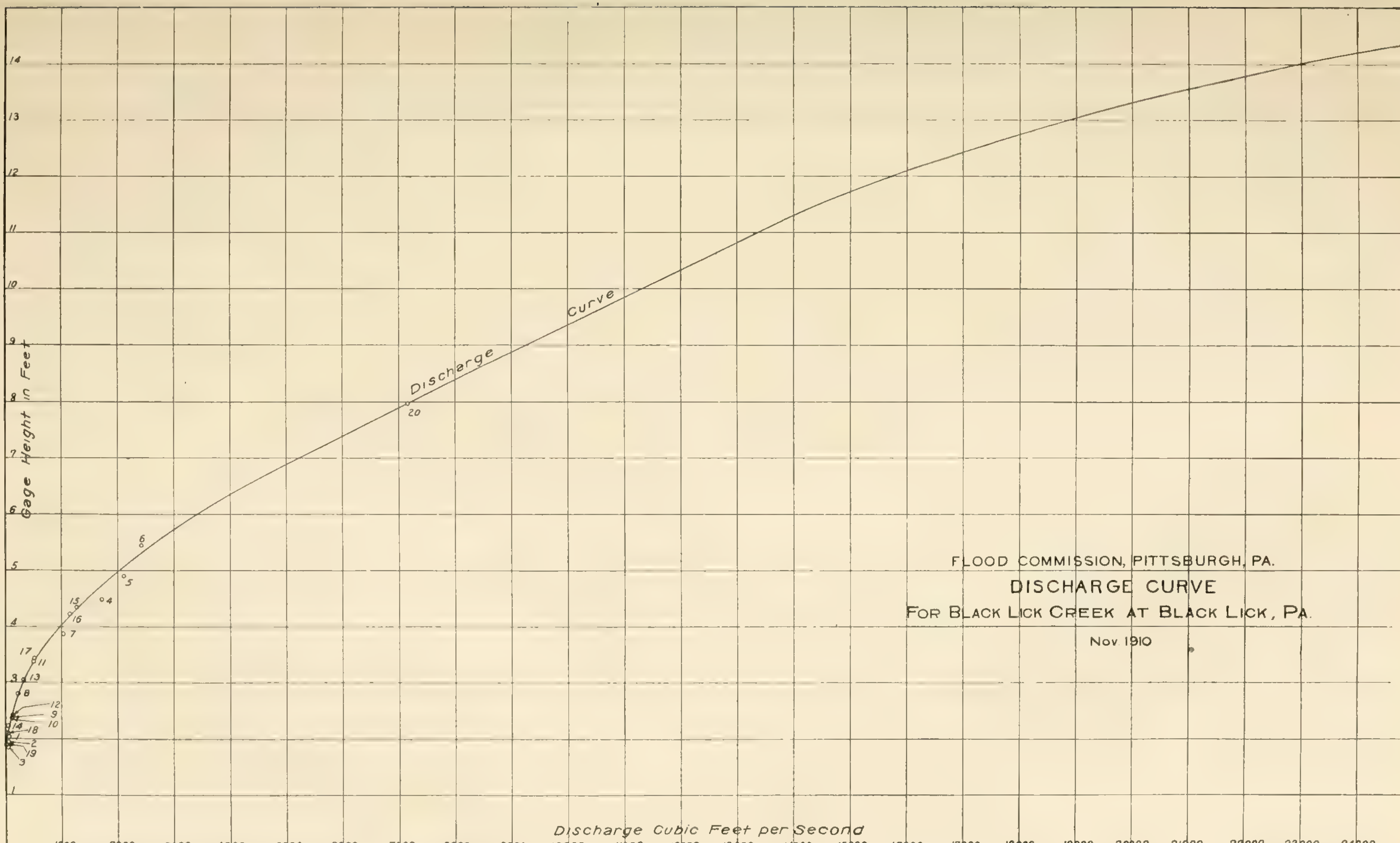
The drainage area above the station is 386 square miles.

Discharge Measurements of Black Lick Creek at Black Lick, Pa.

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
		Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1904						
Aug. 12	R. J. Taylor	205	242	0.26	2.02	63
Sept. 20	E. C. Murphy	130	61	0.74	1.94	45
Sept. 30	N. C. Grover	100	37	0.62	1.84	23
1905						
Mar. 14a	do	183	413	4.17	4.49	1724
Mar. 24a	do	187	473	4.45	4.90	2108
Apr. 12a	A. H. Horton	188	558	4.33	5.45	2416
Apr. 15a	do	175	304	3.42	3.86	1040
June 3a	R. M. Packard	156	153	1.49	2.80	228
Sept. 1a	E. C. Murphy	140	104	1.23	2.36	128
Sept. 1a	L. O. Murphy	150	118	1.11	2.35	131
Nov. 2	E. C. Murphy	199	543	0.93	3.36	507
1906						
May 23	Robert Follansbee	210	373	0.32	2.40	118
1907						
May 27	R. J. Taylor	201	524	0.64	3.04	336
Aug. 14	H. D. Padget	98	177	0.27	2.22	47
Sept. 12	A. H. Horton	207	776	1.66	4.35	1290
1908						
May 11	K. C. Grant	205	759	1.52	4.23	1150
July 24	do	199	609	0.87	3.41	529
Aug. 22a	R. H. Bolster	100	80	0.45	2.09	36
Sept. 24b	C. E. Ryder	28	33	0.20	1.89	7
1910						
Mar. 1	K. C. Grant	208	1499	4.79	7.94	7175

a. Measurement made from coal tipple. b. Wading measurement.

PLATE 97



FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR BLACK LICK CREEK AT BLACK LICK, PA.
Nov 1910
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 21000 22000 23000 24000
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Rating Table for Black Lick Creek at Black Lick, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.85	3	3.20	414	5.10	2155	7.80	6850	10.50	12350
.90	8	.25	441	.20	2280	.90	7050	.60	12555
.95	15	.30	468	.30	2405	8.00	7250	.70	12760
2.00	23	.35	498	.40	2540	.10	7450	.80	12965
.05	33	.40	524	.50	2675	.20	7650	.90	13170
.10	43	.45	552	.60	2810	.30	7850	11.00	13375
.15	55	.50	580	.70	2950	.40	8050	.10	13580
.20	68	.55	620	.80	3100	.50	8250	.20	13790
.25	80	.60	660	.90	3255	.60	8455	.30	14010
.30	93	.65	700	6.00	3420	.70	8660	.40	14240
.35	105	.70	740	.10	3590	.80	8865	.50	14480
.40	118	.75	780	.20	3760	.90	9070	.60	14720
.45	132	.80	820	.30	3935	9.00	9275	.70	14970
.50	146	.85	860	.40	4110	.10	9480	.80	15230
.55	161	.90	905	.50	4295	.20	9685	.90	15500
.60	177	.95	950	.60	4480	.30	9890	12.00	15775
.65	192	4.00	995	.70	4670	.40	10095	.10	16050
.70	208	.10	1085	.80	4860	.50	10300	.20	16330
.75	224	.20	1175	.90	5050	.60	10505	.30	16620
.80	241	.30	1270	7.00	5250	.70	10710	.40	16920
.85	259	.40	1370	.10	5450	.80	10915	.50	17230
.90	279	.50	1475	.20	5650	.90	11120	.60	17545
.95	299	.60	1580	.30	5850	10.00	11325	.70	17870
3.00	320	.70	1690	.40	6050	.10	11530	.80	18205
.05	342	.80	1800	.50	6250	.20	11735	.90	18550
.10	364	.90	1915	.60	6450	.30	11940	13.00	18900
.15	389	5.00	2030	.70	6650	.40	12145	.10	19255

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1904.

Day	August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	----	----	1.88	34	1.95	46	2.00	55	2.05	64
2	----	----	1.90	37	1.92	41	2.00	55	2.30	113
3	----	----	1.92	41	1.85	28	1.98	51	2.25	102
4	----	----	1.90	37	1.85	28	1.95	46	2.25	102
5	----	----	1.90	37	1.90	37	1.90	37	2.30	113
6	----	----	1.90	37	2.10	73	1.90	37	2.30	113
7	----	----	1.90	37	2.15	82	2.00	55	a	----
8	----	----	1.90	37	2.10	73	2.10	73	a	----
9	----	----	2.00	55	2.00	55	2.15	82	a	----
10	----	----	2.10	73	2.00	55	2.20	92	a	----
11	----	----	2.25	102	2.35	123	2.25	102	a	----
12	----	----	2.10	73	2.62	187	2.30	113	a	----
13	----	----	2.02	59	2.50	157	2.25	102	a	----
14	----	----	2.00	55	2.45	145	2.20	92	a	----
15	----	----	2.20	92	2.30	113	2.20	92	a	----
16	----	----	2.25	102	2.30	113	2.15	82	a	----
17	2.18	88	2.15	82	2.20	96	2.15	82	a	----
18	2.15	82	2.00	55	2.20	92	2.15	82	a	----
19	2.12	77	2.00	55	2.10	73	2.12	77	a	----
20	2.02	59	1.95	46	2.00	55	2.00	55	a	----
21	2.20	92	1.90	37	2.25	102	2.00	55	a	----
22	2.32	117	1.90	37	2.65	196	1.98	51	a	----
23	2.42	139	1.95	46	2.55	169	1.95	46	a	----
24	2.35	123	1.95	46	2.45	145	1.90	37	a	----
25	2.25	102	2.00	55	2.30	113	2.00	55	4.20	1175
26	2.50	157	2.02	59	2.20	92	2.00	55	3.90	905
27	2.25	102	2.05	64	2.20	92	2.00	55	6.90	5050
28	2.08	68	2.02	59	2.15	82	2.00	55	5.30	2405
29	1.98	51	2.00	55	2.10	73	2.00	55	4.30	1270
30	1.95	46	2.00	55	2.10	73	2.05	64	3.80	820
31	1.90	37	----	----	2.00	55	----	----	3.70	740

a. Frozen.

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1905.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.6	660	-----	-----	-----	-----	3.4	524	3.0	320	3.1	364	3.1	364	4.1	1085	2.4	134	2.2	92	3.6	660	6.4	4110
2	3.8	820	-----	-----	-----	-----	3.3	468	2.9	278	3.0	320	3.1	364	3.7	740	2.3	113	2.2	92	3.3	468	7.0	5250
3	4.1	1085	-----	-----	-----	-----	3.2	414	2.9	278	2.8	241	2.9	278	3.3	468	2.3	113	2.3	113	3.2	414	10.7	12760
4	3.8	820	-----	-----	-----	-----	3.0	320	2.8	241	2.7	210	2.8	241	3.0	320	2.4	134	2.2	92	3.3	468	6.5	4295
5	3.6	660	-----	-----	-----	-----	3.2	414	2.8	241	2.7	210	3.8	820	3.1	364	2.3	113	2.2	92	3.2	414	5.1	2155
6	3.5	580	-----	-----	-----	-----	3.4	524	2.9	278	2.7	210	3.3	468	2.8	241	2.2	92	2.2	92	3.7	740	4.6	1580
7	3.2	414	-----	-----	-----	-----	3.5	580	3.5	580	5.9	3255	3.1	364	3.0	320	2.2	92	2.2	92	3.7	740	4.0	995
8	3.0	320	2.9	278	7.6	6450	3.4	524	3.4	524	4.6	1580	4.2	1175	3.1	364	2.1	73	2.1	73	3.6	660	3.9	905
9	3.3	468	-----	-----	7.4	6050	3.5	580	3.1	364	3.9	905	3.5	580	3.0	320	2.1	73	2.1	73	3.5	580	3.7	740
10	3.2	414	-----	-----	6.5	4295	3.5	580	2.9	278	3.5	580	3.1	364	2.8	241	2.1	73	2.0	55	3.3	468	3.6	660
11	3.1	364	-----	-----	5.5	2675	6.1	3590	3.0	320	4.2	1175	3.0	320	2.7	210	a6.5	4295	3.4	524	3.2	414	3.5	580
12	4.4	1370	-----	-----	5.1	2155	5.3	2405	4.1	1085	4.4	1370	2.9	278	2.8	241	4.7	1690	4.0	995	3.1	364	3.4	524
13	5.4	2540	-----	-----	4.7	1690	4.5	1475	3.9	905	4.0	995	2.9	278	3.2	414	4.0	995	3.3	468	3.1	364	3.3	468
14	4.6	1580	3.0	320	4.5	1475	4.0	995	4.4	1370	3.6	660	2.9	278	3.0	320	3.5	580	3.0	320	3.2	414	3.2	414
15	4.1	1085	-----	-----	4.4	1370	4.0	995	4.6	1580	3.3	468	2.8	241	3.9	905	3.2	414	2.9	278	3.1	364	3.2	414
16	3.8	820	3.0	320	4.5	1475	3.6	660	4.0	995	3.1	364	2.6	181	3.6	660	3.2	414	2.9	278	3.2	414	3.2	414
17	3.6	660	-----	-----	5.4	2540	3.6	660	3.8	820	3.1	364	2.5	157	3.3	468	3.0	320	2.8	241	3.2	414	3.0	320
18	3.6	660	3.0	320	5.9	3255	3.7	740	3.7	740	3.0	320	2.4	134	3.0	320	2.9	278	2.7	210	3.1	364	3.0	320
19	3.4	524	-----	-----	8.4	8050	3.5	580	3.5	580	3.7	740	2.5	157	2.8	241	2.8	241	3.7	740	3.0	320	3.0	320
20	3.5	580	-----	-----	7.0	5250	3.4	524	3.3	468	3.2	414	3.0	320	2.7	210	2.7	210	6.0	3420	3.0	320	2.9	278
21	3.5	580	3.4	524	8.6	8455	4.8	1800	3.2	414	4.2	1175	2.8	241	2.7	210	2.6	181	4.6	1580	2.9	278	4.9	1915
22	3.3	468	-----	-----	7.0	5250	5.3	2405	3.0	320	5.8	3100	2.9	278	2.6	181	2.5	157	4.1	1085	2.8	241	4.5	1475
23	3.2	414	-----	-----	6.3	3935	4.6	1580	2.9	278	4.9	1915	2.7	210	2.5	157	2.4	134	3.9	905	2.8	241	4.3	1270
24	3.3	468	-----	-----	5.0	2030	4.2	1175	2.9	278	4.4	1370	3.1	364	2.4	134	2.4	134	3.7	740	2.8	241	4.1	1085
25	3.0	320	-----	-----	5.4	2540	3.8	820	2.7	210	4.0	995	2.8	241	3.5	580	2.3	113	3.8	820	3.0	320	3.6	660
26	2.7	210	-----	-----	5.5	2675	3.6	660	2.7	210	3.7	740	2.6	181	3.0	320	2.3	113	4.0	995	2.9	278	3.7	740
27	3.0	320	-----	-----	4.9	1915	3.6	660	2.8	241	3.4	524	2.6	181	2.7	210	2.3	113	3.7	740	2.8	241	3.6	660
28	3.0	320	-----	-----	4.5	1475	3.4	524	2.6	181	3.2	414	2.5	157	2.6	181	2.3	113	3.5	580	2.9	278	3.7	740
29	3.0	320	-----	-----	4.0	995	3.3	468	2.5	157	3.0	320	3.7	740	2.6	181	2.2	92	3.3	468	7.7	6650	6.5	4295
30	3.0	320	-----	-----	4.0	995	3.2	414	2.6	181	2.9	278	4.3	1270	2.5	157	2.2	92	3.1	364	7.0	5250	5.1	2155
31	----	-----	-----	-----	3.6	660	-----	-----	3.1	364	----	-----	4.7	1690	2.4	134	----	----	3.1	364	----	-----	4.4	1370

Creek frozen Jan. 31 to Mar. 7, inclusive. a. Approximate.

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1907.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	-----	-----	3.50	580	3.25	441	3.75	780	3.50	580	2.85	259	3.45	552	2.35	105	2.10	43	3.45	552	3.10	364	2.90	278
2	-----	-----	3.45	552	4.50	1475	3.55	620	3.40	524	4.15	1130	3.20	414	2.35	105	2.50	146	3.15	389	3.30	468	2.90	278
3	-----	-----	4.25	1220	4.40	1370	3.40	524	3.25	441	3.60	660	3.00	320	2.30	93	3.60	660	3.00	320	5.25	2340	2.80	241
4	-----	-----	3.90	905	3.85	860	3.45	552	3.75	780	3.35	498	2.85	259	2.35	105	3.50	580	4.60	1580	4.95	1970	2.80	241
5	-----	-----	3.65	700	3.70	740	3.50	580	3.85	865	3.55	620	2.70	208	2.30	93	3.15	389	4.80	1800	4.45	1420	2.80	241
6	-----	-----	3.55	629	3.65	700	3.35	498	3.70	740	3.70	740	2.65	192	2.45	132	2.95	299	4.00	995	4.20	1175	2.70	208
7	-----	-----	3.95	950	3.40	524	3.20	414	3.80	820	3.55	620	2.95	299	2.55	161	2.75	224	3.60	660	5.75	3025	2.70	208
8	4.65	1635	4.85	1855	3.55	620	3.30	468	3.70	740	3.35	498	3.10	364	2.40	118	2.60	177	4.30	1270	4.95	1970	2.70	208
9	4.95	1970	4.70	1690	3.40	524	3.35	498	4.25	1220	3.15	389	2.75	224	2.30	93	2.55	161	4.30	1270	4.65	1635	2.75	224
10	4.80	1800	4.70	1690	3.45	552	3.40	524	4.35	1320	3.00	320	2.70	208	2.50	146	2.65	192	3.80	820	4.25	1220	4.35	1320
11	4.40	1370	4.65	1635	3.45	552	3.30	468	4.10	1085	3.25	441	2.65	192	2.45	132	4.80	1800	3.55	620	3.95	950	5.40	2540
12	6.10	2590	4.60	1580	3.65	700	3.35	498	3.75	780	4.60	1580	3.10	364	2.35	105	4.60	1580	3.60	660	3.70	740	4.40	1370
13	6.10	3590	4.60	1580	12.00	15775	3.45	552	3.65	700	4.15	1130	3.10	364	2.30	93	3.65	700	3.45	552	3.45	552	3.85	860
14	8.40	8050	4.60	1580	13.20	19615	3.55	620	3.45	552	5.90	3255	2.75	224	2.25	80	3.25	441	3.15	389	3.35	498	3.85	860
15	7.10	5450	4.60	1580	8.00	7250	3.50	580	3.35	498	4.75	1745	2.60	177	2.20	68	3.05	342	3.00	320	3.15	389	3.90	905
16	5.85	3175	4.60	1580	5.95	3335	3.85	860	3.40	524	4.20	1175	2.50	146	2.20	68	2.85	259	2.95	299	3.05	342	3.75	780
17	5.20	2280	4.35	1320	5.40	2540	3.90	905	3.30	468	3.80	820	2.55	161	2.20	68	2.85	259	2.85	259	3.00	320	3.55	620
18	4.80	1800	4.05	1040	5.65	2880	3.70	740	3.15	389	3.55	620	2.65	192	2.20	68	2.95	299	2.80	241	3.00	320	3.50	580
19	9.40	10095	3.95	950	6.20	3760	3.65	700	3.10	364	3.35	498	2.60	177	2.15	55	3.25	441	2.70	208	3.20	414	3.35	498
20	8.10	7450	4.25	1220	9.00	9275	3.60	660	3.05	342	3.25	441	2.50	146	2.10	43	3.25	441	2.70	208	3.10	364	3.15	389
21	5.85	3175	4.05	1040	6.10	3590	3.60	660	2.95	299	3.15	389	2.45	132	2.15	55	3.25	441	2.75	224	3.10	364	3.05	342
22	4.80	1800	3.75	780	5.05	2090	3.50	580	2.90	278	3.00	320	2.40	118	2.15	55	3.70	740	2.70	208	3.10	364	3.05	342
23	4.15	1130	3.60	660	4.60	1580	3.40	524	2.80	241	3.30	468	2.35	105	2.15	55	3.55	620	2.60	177	3.00	320	6.60	4480
24	3.70	740	3.50	580	4.20	1175	4.40	1370	2.80	241	3.00	320	2.35	105	2.45	132	3.55	620	2.60	177	3.00	320	7.25	5750
25	4.05	1040	3.40	524	3.95	950	4.10	1085	2.80	241	2.90	278	2.50	146	2.65	192	3.30	468	2.60	177	3.00	320	5.45	2605
26	3.80	820	3.45	552	3.85	860	3.90	905	2.95	299	2.90	278	2.85	259	2.45	132	3.05	342	2.50	146	3.00	320	4.75	1745
27	3.35	498	3.35	498	5.15	2215	3.75	780	3.05	342	3.00	320	2.95	299	2.30	93	2.90	278	2.80	241	3.00	320	4.35	1320
28	3.65	700	3.55	620	5.00	2030	3.55	620	3.05	342	2.85	259	2.75	224	2.25	80	2.85	259	4.60	1580	2.95	299	4.55	1525
29	3.95	950	-----	-----	4.65	1635	3.45	552	2.85	259	2.75	224	2.55	161	2.20	68	3.65	700	3.95	950	2.90	278	4.85	1855
30	3.80	820	-----	-----	4.30	1270	3.40	524	2.75	224	3.55	620	2.40	118	2.20	68	3.80	820	3.50	580	2.90	278	4.40	1370
31	3.60	660	-----	-----	3.95	950	-----	-----	2.70	208	----	-----	2.35	105	2.15	55	----	-----	3.25	441	----	-----	4.30	1270

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1908.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.95	950	3.25	441	3.60	660	4.35	1320	4.35	1320	3.55	620	2.40	118	2.30	93	2.08	39	2.08	39	2.08	39	2.08	39
2	3.75	780	a4.45	1420	6.90	5050	4.25	1220	4.15	1130	3.35	498	2.45	132	2.30	93	2.08	39	2.08	39	2.08	39	2.08	39
3	3.55	620	4.60	1580	6.20	3761	4.10	1085	4.40	1370	3.15	389	2.50	146	2.30	93	2.08	39	2.08	39	1.98	20	1.98	20
4	3.40	524	4.75	1745	5.35	2470	3.85	860	4.05	1040	3.00	320	2.50	146	2.30	93	2.08	39	2.08	39	2.03	29	2.03	29
5	3.75	780	4.35	1320	5.05	2090	3.70	740	4.15	1130	2.90	278	2.50	146	2.20	68	2.08	39	2.03	29	2.08	39	2.08	39
6	3.35	498	4.00	995	8.35	7950	3.80	820	4.55	1525	2.80	241	2.35	105	2.40	118	1.98	20	1.98	20	2.08	39	2.08	39
7	3.30	468	3.65	700	9.15	9580	3.75	780	5.85	3175	2.70	208	2.40	118	2.55	161	1.98	20	1.98	20	2.08	39	2.30	93
8	3.35	498	3.30	468	6.50	4295	4.35	1320	5.80	3100	2.65	192	2.40	118	2.65	192	1.98	20	1.98	20	2.08	39	2.45	132
9	3.30	468	3.15	389	6.45	4205	5.80	3100	5.00	2030	2.70	208	2.35	105	2.55	161	1.98	20	1.98	20	2.08	39	2.45	132
10	3.20	414	3.05	342	5.45	2605	4.95	1970	4.70	1690	3.40	524	2.30	93	2.35	105	1.98	20	1.98	20	2.08	39	2.30	93
11	3.35	498	2.95	299	5.00	2030	5.15	2215	4.20	1175	3.00	320	2.20	68	2.55	161	1.98	20	1.98	20	2.08	39	2.30	93
12	4.35	1320	3.05	342	5.20	2280	4.50	1475	3.95	950	2.80	241	2.30	93	2.40	118	1.88	6	1.98	20	2.08	39	2.50	146
13	6.80	4860	3.90	905	5.45	2605	4.25	1220	3.75	780	2.65	192	2.30	93	2.35	105	1.98	20	1.98	20	2.18	63	2.60	177
14	5.30	2405	5.30	2405	6.10	3590	3.90	905	3.60	660	2.60	177	2.35	105	2.30	93	1.98	20	1.98	20	2.18	63	2.40	118
15	4.55	1525	10.00	11325	5.80	3100	3.85	860	4.55	1525	3.05	342	2.55	161	2.10	43	1.93	12	1.98	20	2.18	63	2.40	118
16	4.35	1320	7.50	6250	6.10	3590	4.45	1420	4.75	1745	3.15	389	2.45	132	2.20	68	1.88	6	1.98	20	2.18	63	2.20	68
17	3.90	905	5.45	2605	5.20	2280	4.00	995	6.90	5050	2.85	259	2.40	118	2.20	68	1.88	6	1.98	20	2.18	63	2.45	132
18	3.75	780	4.55	1525	6.20	3760	3.95	950	5.90	3255	2.70	208	2.30	93	2.45	132	1.88	6	1.98	20	2.18	63	5.70	2950
19	3.60	660	4.30	1270	10.80	12965	5.90	3255	6.20	3760	2.60	177	2.30	93	2.45	132	1.88	6	1.98	20	2.18	63	4.70	1690
20	3.50	580	4.05	1040	6.65	4575	4.90	1915	7.00	5250	3.10	364	2.30	93	2.25	80	1.88	6	1.98	20	2.18	63	3.70	740
21	3.50	580	3.75	780	5.35	2470	4.40	1370	5.40	2540	3.15	389	2.40	118	2.25	80	1.88	6	1.98	20	2.18	63	3.05	342
22	3.90	905	3.70	740	4.70	1690	4.05	1040	4.75	1745	3.00	320	3.60	660	2.20	68	1.88	6	1.98	20	2.18	63	2.85	259
23	3.90	905	3.35	498	4.40	1370	3.85	860	4.40	1370	2.85	259	2.70	208	2.75	224	1.88	6	1.98	20	2.18	63	2.65	192
24	3.60	660	3.40	524	4.50	1475	3.65	700	4.00	995	2.70	208	3.60	660	2.55	161	1.88	6	1.98	20	2.18	63	2.70	208
25	3.55	620	3.35	498	4.10	1085	3.55	620	3.65	700	2.85	259	4.35	1320	2.30	93	1.88	6	1.98	20	2.08	39	3.05	342
26	3.45	552	3.40	524	3.85	860	3.85	860	3.50	580	2.85	259	3.20	414	2.30	93	1.88	6	1.98	20	2.08	39	2.95	299
27	4.15	1130	3.35	498	3.70	740	3.65	700	3.50	580	2.65	192	2.90	278	2.30	93	1.88	6	1.98	20	2.08	39	2.60	177
28	3.95	950	3.15	389	3.80	820	3.45	552	3.40	524	2.60	177	2.65	192	2.20	68	1.93	12	2.08	39	2.08	39	2.75	224
29	3.75	780	3.15	389	4.95	1970	3.30	468	3.30	468	2.60	177	2.50	146	2.20	68	2.08	39	2.08	39	2.08	39	2.70	208
30	3.40	524	-----	-----	4.95	1970	3.40	524	3.20	414	2.50	146	2.40	118	2.05	33	2.08	39	2.08	39	2.08	39	2.65	192
31	3.20	414	-----	-----	4.55	1525	-----	-----	3.75	780	-----	-----	2.20	68	2.10	43	-----	-----	2.08	39	-----	-----	3.25	441

a. Creek frozen.

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.10	364	3.10	364	4.20	1175	3.65	700	d7.85	6950	2.60	177	2.80	241	2.87	267	2.17	60	2.07	37	2.17	60	2.27	86
2	2.75	224	3.05	342	b7.13	5510	3.60	660	6.45	4200	2.70	208	2.70	208	2.62	183	2.17	60	1.97	18	2.17	60	2.27	86
3	2.95	299	3.10	364	6.75	4765	3.60	660	5.40	2540	2.80	241	2.65	192	2.42	124	2.17	60	1.97	18	2.27	86	2.23	75
4	3.30	468	3.10	364	6.45	4200	3.55	620	5.75	3025	3.15	389	2.65	192	2.37	110	2.17	60	1.97	18	2.32	98	2.27	86
5	3.75	780	3.50	580	5.15	2215	3.35	498	4.95	1970	3.60	660	2.50	146	2.27	86	2.17	60	1.97	18	2.27	86	2.23	75
6	4.40	1370	4.50	1475	4.65	1635	3.75	780	4.65	1635	3.90	905	2.40	118	2.27	86	2.17	60	1.97	18	2.27	86	2.23	75
7	3.85	860	4.15	1130	4.45	1420	5.90	3255	4.25	1220	3.40	524	2.40	118	2.27	86	2.17	60	1.97	18	2.17	60	2.41	221
8	3.40	524	3.85	860	4.45	1420	4.70	1690	3.95	950	3.15	389	2.30	93	2.27	86	2.17	60	1.97	18	2.22	73	2.57	168
9	3.40	524	3.75	780	4.60	1580	4.45	1420	3.75	780	3.70	740	2.30	93	2.27	86	2.07	37	1.97	18	2.42	124	2.45	132
10	3.20	414	4.05	1040	5.00	2030	4.10	1085	3.60	660	5.20	2280	2.25	80	2.17	60	2.07	37	1.97	18	2.43	126	2.39	116
11	3.35	498	4.00	995	4.75	1745	3.85	860	3.70	740	6.25	3845	2.25	80	2.17	60	2.07	37	2.17	60	2.37	110	2.42	124
12	3.50	580	3.75	780	4.25	1220	3.70	740	3.55	620	4.80	1800	2.30	93	2.17	60	2.07	37	2.82	248	2.33	100	2.33	100
13	3.30	468	4.50	1475	4.10	1085	3.70	740	3.35	498	4.20	1175	2.25	80	2.07	37	2.07	37	2.62	183	2.26	82	2.50	146
14	3.30	468	4.70	1690	4.00	995	6.57	4425	3.20	414	4.10	1085	2.40	118	2.07	37	1.97	18	2.42	124	2.24	78	4.26	1230
15	5.05	2090	5.40	2540	3.70	740	5.25	2340	3.05	342	3.65	700	2.30	93	2.17	60	1.97	18	2.22	73	2.23	75	3.57	635
16	4.80	1800	6.23	3810	3.60	660	4.60	1580	3.10	364	3.40	524	2.25	80	2.62	183	2.02	27	2.27	86	2.35	105	3.09	360
17	3.95	950	5.80	3100	3.45	552	4.20	1175	3.00	320	3.25	441	2.30	93	2.82	248	2.07	37	2.17	60	2.43	126	2.83	252
18	3.85	860	4.85	1855	3.35	498	3.95	950	2.90	278	3.20	414	2.25	80	2.62	183	2.07	37	2.17	60	2.45	132	2.85	259
19	3.55	620	4.45	1420	3.50	580	3.75	780	2.80	241	3.15	389	2.20	68	2.42	124	1.97	18	2.17	60	2.37	110	2.63	188
20	3.60	660	4.75	1745	3.85	860	3.65	700	2.70	208	2.90	278	2.15	55	2.32	98	1.97	18	2.17	60	2.33	100	2.63	186
21	3.45	552	4.60	1580	3.75	780	4.05	1040	3.05	342	2.80	241	2.15	55	2.27	86	1.97	18	2.22	73	2.29	91	2.65	192
22	3.75	780	4.55	1525	3.55	620	5.65	2880	3.05	342	2.80	241	2.20	68	2.27	86	1.97	18	2.27	86	2.29	91	2.59	174
23	4.65	1635	5.10	2155	3.45	552	5.20	2280	2.90	278	2.80	241	e3.68	724	2.17	60	2.02	27	2.37	110	2.35	105	2.57	168
24	5.45	2605	a8.63	8515	3.40	524	4.85	1855	2.80	241	3.05	342	3.20	414	2.17	60	2.12	48	2.97	307	2.46	135	2.52	152
25	4.65	1635	6.55	4385	4.45	1420	4.30	1270	2.65	192	3.00	320	2.70	208	2.17	60	2.17	60	2.92	286	2.43	126	2.54	158
26	4.20	1175	5.35	2470	4.80	1800	4.60	1580	2.70	208	2.90	278	2.50	146	2.17	60	2.17	60	2.62	183	2.38	113	2.53	155
27	3.85	860	4.80	1800	4.75	1745	4.25	1220	2.70	208	2.90	278	2.45	132	2.17	60	2.07	37	2.47	138	2.35	105	2.53	155
28	3.65	700	4.55	1525	4.55	1525	4.50	1475	3.05	342	3.62	676	2.35	105	2.17	60	2.07	37	2.42	124	2.31	95	2.50	146
29	3.50	580	....	....	4.25	1220	4.60	1580	2.95	299	3.55	620	2.30	93	2.17	60	2.07	37	2.32	98	2.29	91	2.55	161
30	3.35	498	....	....	3.95	950	c7.20	5650	2.65	192	3.05	342	2.70	208	2.17	60	2.07	37	2.27	86	2.30	93	2.55	161
31	3.10	364	....	....	3.85	860	.....	.....	2.70	208	....	....	3.27	454	2.17	60	....	..	2.17	60	....	..	2.49	143

a. Max. at noon, 8.8 = 8865 sec.-ft.
b. Max. at noon, 7.5 = 6250 sec.-ft.
c. Max. 6 P.M., 7.5 = 6250 sec.-ft.
d. Max. 6 P.M., 8.0 = 7250 sec.-ft.
e. Max. at noon, 4.0 = 995 sec.-ft.

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.44	129	3.57	636	8.28	7810	2.88	271	3.63	684	3.34	490	2.46	135	2.12	48	2.02	27	2.28	88	2.26	82	3.08	356
2	2.87	267	3.44	546	7.28	5810	2.82	248	3.42	535	3.49	574	2.38	113	2.09	41	2.12	48	2.23	75	2.32	98	2.98	312
3	4.69	1679	3.63	684	7.06	5370	2.77	231	3.34	490	3.38	513	2.38	113	2.06	35	2.43	126	2.21	70	2.30	93	2.98	312
4	4.65	1635	3.67	716	6.19	3743	2.74	221	3.40	524	3.22	425	2.33	101	2.05	33	5.19	2268	2.20	68	2.32	98	2.94	275
5	4.05	1040	3.56	628	5.95	3335	2.76	228	3.24	436	3.14	384	2.30	93	2.04	31	4.16	1139	2.20	68	2.31	96	2.86	263
6	5.47	2634	3.33	485	5.84	3162	2.74	221	3.10	364	3.79	812	2.28	88	2.04	31	3.74	772	2.18	63	2.28	88	2.78	235
7	5.15	2215	3.23	430	6.24	3830	2.72	215	3.02	329	3.56	628	2.35	105	2.04	31	3.80	820	2.22	73	2.26	82	2.87	266
8	5.27	2368	3.32	479	5.10	2155	2.68	202	2.98	312	3.38	513	2.40	118	2.06	35	3.21	419	2.18	63	2.26	82	2.82	248
9	7.63	6510	3.37	507	4.53	1507	2.66	196	2.99	316	3.22	425	2.34	103	2.03	29	3.08	355	2.20	68	2.24	78	2.78	235
10	7.19	5630	3.59	652	4.16	1139	2.62	183	3.00	320	3.72	756	2.32	98	2.14	53	2.96	304	2.18	63	2.26	82	2.81	245
11	6.51	4314	3.55	620	3.95	950	2.56	165	3.01	324	3.84	854	2.28	88	2.30	93	2.84	256	2.18	63	2.30	93	2.88	272
12	6.33	3988	3.45	552	3.82	837	2.53	155	3.32	479	3.72	756	2.24	78	2.38	113	2.74	221	2.19	66	2.30	93	2.94	295
13	6.43	4166	3.53	604	3.70	740	2.50	146	3.05	342	3.52	596	2.35	105	2.26	82	3.25	441	2.16	57	2.30	93	2.94	295
14	6.34	4005	3.49	574	3.83	846	2.50	146	2.92	286	3.37	507	2.40	118	2.19	66	3.14	384	2.13	50	2.28	88	3.10	364
15	5.52	2702	3.37	507	3.66	708	2.48	140	2.84	256	3.25	441	2.33	101	2.12	48	2.86	263	2.12	48	2.44	129	3.08	356
16	4.51	1486	b5.37	2500	3.40	524	2.59	174	2.80	241	3.58	644	e4.56	1538	2.19	66	2.66	195	2.12	48	2.38	113	3.03	334
17	3.81	829	5.88	3224	3.44	546	2.68	202	2.74	221	3.38	513	4.10	1085	2.18	63	2.54	158	2.12	48	2.38	113	3.01	324
18	a10.15	11630	5.01	2042	3.34	490	3.41	530	2.92	286	3.23	430	3.22	425	2.20	68	2.46	135	2.10	43	2.40	118	3.00	320
19	8.35	7950	4.31	1280	3.32	479	3.79	812	3.02	329	3.18	404	2.78	234	2.28	88	2.42	123	2.10	43	2.36	107	3.16	394
20	5.76	3040	4.05	1040	3.45	552	3.79	812	2.87	266	3.04	337	2.61	180	2.21	70	2.38	113	2.10	43	2.34	103	3.56	628
21	7.11	5470	4.69	1679	3.66	708	4.54	1517	3.56	628	2.91	282	2.47	138	2.18	63	2.35	105	2.10	43	2.32	98	3.66	708
22	7.16	5570	5.96	3354	3.54	612	4.24	1213	3.86	871	2.76	228	2.38	113	2.15	55	2.31	95	2.79	238	2.40	118	3.62	676
23	5.39	2527	5.35	2470	3.44	546	3.88	888	3.56	628	2.72	215	2.34	103	2.10	43	2.29	91	2.77	230	2.41	121	3.54	612
24	4.81	1812	4.61	1591	3.39	518	3.78	804	3.39	518	2.60	177	2.30	93	2.06	35	2.35	105	2.68	202	2.48	141	4.60	1580
25	4.37	1340	4.35	1320	3.34	490	d6.03	3471	4.05	1040	2.52	152	2.27	85	2.06	35	2.35	105	2.46	135	2.56	164	4.25	1220
26	3.97	968	4.07	1058	3.25	441	5.52	2702	3.86	871	2.46	135	2.24	78	2.11	45	2.40	118	2.38	113	2.81	244	3.92	923
27	5.01	2042	6.01	3437	3.16	394	4.76	1756	3.56	628	2.41	121	2.22	73	2.08	39	2.34	103	2.36	107	2.72	214	3.76	788
28	4.64	1624	c9.27	9829	3.02	329	4.27	1242	3.38	513	2.66	196	2.22	73	2.07	37	2.38	113	2.35	105	2.80	241	3.65	700
29	4.21	1185	....	....	2.96	303	4.00	995	3.22	425	2.79	238	2.18	63	2.05	33	2.48	141	2.32	98	3.57	636	6.00	3420
30	3.86	871	....	....	2.97	307	3.88	888	3.13	379	2.57	168	2.18	63	2.06	35	2.32	98	2.30	93	3.38	513	7.63	7110
31	3.79	812	....	....	2.92	286	....	....	3.22	425	....	....	2.15	55	2.03	29	....	....	2.30	93	....	.....	5.98	3397

a. Max. at noon, 10.97 = 13314 sec.-ft.
b. Max. at noon, 6.97 = 5190 sec.-ft.
c. Max. at noon, 10.17 = 11674 sec.-ft.
d. Max. at 6 P.M. 6.7 = 4670 sec.-ft.
e. Max. at 9.00 P.M. 7.3 = 5850 sec.-ft.

Daily Gage Heights and Discharges of Black Lick Creek at Black Lick, Pa., for 1911.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.23	2317	4.58	1559	3.74	772	3.74	772	3.52	596	2.34	103	2.26	82	1.98	20	3.10	364	----	----	----	----	----	----
2	5.30	2405	4.30	1270	3.80	820	3.73	764	3.76	788	2.34	103	2.12	48	1.98	20	2.79	238	----	----	----	----	----	----
3	5.54	2769	4.00	995	3.60	660	3.72	756	3.54	612	2.36	108	2.10	43	2.00	23	2.60	177	----	----	----	----	----	----
4	4.76	1756	4.30	1270	3.56	628	3.75	780	3.32	480	2.30	93	2.14	53	2.18	63	----	----	----	----	----	----	----	----
5	4.15	1130	4.15	1130	3.28	457	4.92	1938	3.17	399	3.01	324	2.11	45	2.19	65	----	----	----	----	----	----	----	----
6	4.01	1004	3.74	772	3.45	552	5.98	3387	3.10	364	3.17	399	2.10	43	2.44	129	----	----	----	----	----	----	----	----
7	3.88	888	3.69	732	3.44	547	6.02	3454	3.03	333	2.76	227	2.10	43	2.24	78	----	----	----	----	----	----	----	----
8	3.66	708	3.62	676	3.36	503	5.26	2355	2.98	312	2.64	189	2.26	82	2.16	45	----	----	----	----	----	----	----	----
9	3.93	932	3.65	700	3.28	457	5.00	2030	2.92	287	2.48	140	2.24	78	2.07	37	----	----	----	----	----	----	----	----
10	3.56	628	3.44	546	3.62	676	4.86	1866	2.90	279	2.40	118	2.16	45	2.04	31	----	----	----	----	----	----	----	----
11	3.74	772	3.25	441	3.80	820	4.38	1400	2.87	266	2.37	110	2.18	50	2.02	27	----	----	----	----	----	----	----	----
12	5.24	2330	3.22	425	3.70	740	4.12	1103	2.81	245	2.89	274	2.17	47	2.00	23	----	----	----	----	----	----	----	----
13	6.40	4110	3.38	514	4.17	1148	4.02	1013	2.74	221	3.63	684	2.14	53	2.00	23	----	----	----	----	----	----	----	----
14	8.97	9213	3.40	524	3.90	905	4.12	1103	2.67	198	3.17	399	2.12	48	2.00	23	----	----	----	----	----	----	----	----
15	8.31	7870	5.30	2405	3.72	756	4.68	1660	2.63	186	2.77	231	2.10	43	1.98	20	----	----	----	----	----	----	----	----
16	6.04	3468	4.60	1580	3.44	547	4.32	1290	2.58	171	2.62	183	2.08	39	1.96	16	----	----	----	----	----	----	----	----
17	4.83	1834	4.29	1261	3.54	612	4.07	1058	2.56	164	2.52	152	2.04	31	2.10	43	----	----	----	----	----	----	----	----
18	4.20	1175	5.12	2180	3.63	684	3.82	837	2.56	164	2.47	138	2.04	31	2.22	73	----	----	----	----	----	----	----	----
19	4.10	1085	5.20	2280	3.66	708	3.68	724	2.52	152	2.45	132	2.03	29	2.12	48	----	----	----	----	----	----	----	----
20	4.84	1846	4.66	1646	4.22	1194	4.76	1756	2.56	164	2.40	118	2.00	23	2.04	31	----	----	----	----	----	----	----	----
21	3.78	796	4.20	1175	3.94	941	4.58	1559	2.56	164	2.34	103	2.10	43	2.01	25	----	----	----	----	----	----	----	----
22	3.96	959	3.78	804	3.83	845	4.59	1569	2.50	146	2.27	85	2.08	39	2.00	23	----	----	----	----	----	----	----	----
23	3.64	692	3.78	804	4.03	1022	5.20	2280	2.44	129	2.23	75	2.09	41	2.06	35	----	----	----	----	----	----	----	----
24	3.26	447	3.62	676	3.68	724	4.76	1756	2.58	171	2.17	60	2.12	48	2.07	37	----	----	----	----	----	----	----	----
25	3.40	524	3.58	644	3.54	612	4.35	1320	2.57	168	2.28	87	2.20	68	2.13	50	----	----	----	----	----	----	----	----
26	3.58	644	3.90	905	3.50	580	4.04	1031	2.44	129	2.73	218	2.17	60	2.26	82	----	----	----	----	----	----	----	----
27	3.96	959	4.43	1401	3.78	804	3.84	852	2.40	118	2.75	224	2.12	48	2.44	129	----	----	----	----	----	----	----	----
28	6.07	3539	4.10	1085	3.80	820	3.60	660	2.34	103	2.54	158	2.10	43	3.11	369	----	----	----	----	----	----	----	----
29	5.06	2105	----	----	3.61	668	3.46	557	2.30	93	2.46	135	2.08	39	3.27	453	----	----	----	----	----	----	----	----
30	6.50	4295	----	----	3.79	812	3.55	620	2.34	103	2.33	101	2.04	31	3.87	877	----	----	----	----	----	----	----	----
31	5.06	2105	----	----	3.88	888	----	----	2.40	118	----	----	2.00	31	3.20	414	----	----	----	----	----	----	----	----

Estimated Monthly Discharge of Black Lick Creek at Black Lick, Pa.

[Drainage area, 386 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
September	102	34	55	0.143	0.159
October	196	28	92	0.239	0.276
November	113	37	66	0.171	0.191
1905					
January	2540	210	672	1.745	1.946
March 8-31	8455	660	---	-----	-----
April	3590	320	935	2.429	2.710
May	1580	157	486	1.262	1.455
June	3255	210	853	2.216	2.473
July	1690	134	417	1.083	1.249
August	1085	134	351	0.912	1.051
September	4295	73	390	1.013	1.130
October	3420	55	548	1.423	1.641
November	6650	241	779	2.023	2.257
December	12760	278	1738	4.514	5.204
1907					
January 8-31	10095	660	----	-----	-----
February	1855	498	1074	2.790	2.905
March	19615	441	2962	7.693	8.869
April	1370	414	655	1.701	1.898
May	1320	208	539	1.400	1.614
June	3255	224	697	1.810	2.019
July	552	105	224	0.582	0.671
August	192	43	94	0.244	0.281
September	1800	43	491	1.275	1.422
October	1800	146	591	1.535	1.769
November	3025	278	789	2.049	2.275
December	5750	208	1144	2.971	3.425
11 months	19615	43	851	2.186	27.138
1908					
January	4860	414	931	2.418	2.788
February	11325	299	1455	3.779	4.076
March	12965	660	3207	8.330	9.604
April	3255	468	1204	3.127	3.489
May	5250	414	1689	4.387	5.058
June	620	146	284	0.738	0.823
July	1320	68	208	0.540	0.623
August	224	33	103	0.268	0.309
September	39	6	18	0.047	0.053
October	39	20	25	0.065	0.075
November	63	20	48	0.125	0.139
December	2950	20	315	0.818	0.943
The year	12965	6	791	2.054	27.980
1909					
January	2605	224	845	2.195	2.530
February	8865	342	1809	4.699	4.893
March	6250	498	1512	3.927	4.528
April	6250	498	1550	4.026	4.492
May	7250	192	994	2.582	2.976
June	3845	177	691	1.795	2.002
July	995	55	159	0.413	0.476
August	267	37	96	0.249	0.287
September	60	18	41	0.106	0.118
October	307	18	89	0.231	0.266
November	135	60	97	0.252	0.281
December	1230	75	205	0.532	0.613
The year	8865	18	674	1.751	23.462

Estimated Monthly Discharge of Black Lick Creek at Black Lick, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	13314	129	2981	7.723	8.903
February	11674	430	1552	4.018	4.184
March	7810	286	1596	4.135	4.767
April	4670	140	699	1.811	2.020
May	1040	221	460	1.192	1.374
June	854	121	430	1.114	1.243
July	5850	55	192	0.497	0.573
August	113	29	51	0.132	0.152
September	2268	27	321	0.832	0.995
October	238	43	86	0.223	0.257
November	636	78	147	0.381	0.425
December	7110	235	886	2.295	2.646
The year	13314	27	784	2.028	27.539
1911					
January	9213	447	2107	5.458	6.293
February	2405	425	1086	2.813	2.929
March	1194	457	739	1.915	2.208
April	3454	557	1408	3.648	4.070
May	788	93	252	0.653	0.753
June	684	60	182	0.472	0.527
July	82	23	47	0.121	0.139
August	877	16	107	0.278	0.320

CROOKED CREEK AT HILEMAN'S FARM, PA.

This station, situated on the steel highway bridge at Hileman's Farm, Armstrong County, Pa., 3 miles above the mouth of Crooked Creek, was established October 16, 1909, by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh.

Originally a staff gage, bolted to the upstream side of the right abutment, was used. This was carried away by ice January 16, 1910, and was replaced by a standard chain gage. The chain measures 22.72 feet from marker to bottom of weight.

The top of the plate riveted to the first floor-beam from the right bank, upstream side of bridge, is 21.60 feet above the zero of the gage. The ledge on the upstream, right wing-wall, upper side of lower course, about 3 feet in from face of abutment, is 0.93 foot above zero of the gage.

Measurements are taken from the downstream side of the bridge. The initial point for soundings is the top edge of the right abutment. At low water, measurements are taken by wading about 200 yards below the bridge.

The bed is rocky and fairly permanent. The section near the station is deep and has a low velocity at low stages. The banks are high and do not overflow. There is a range of about 12 feet between extreme high and extreme low water.

The gage is read twice daily by J. T. Hileman.

The drainage area above the station is 279 square miles.

Discharge Measurements of Crooked Creek at Hileman's Farm, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Feb.	3	K. C. Grant	...	408	0.70	2.50	285
Mar.	1	Samuel Eckles	138	1037	5.08	7.12	5260
Mar.	1	do	137	970	4.61	6.62	4466
Mar.	3	K. C. Grant	137	813	3.72	5.45	3025
Mar.	5	V. F. Hammel	136	682	2.93	4.53	2001
May	25	H. P. Drake	135	314	0.42	1.94	130
June	25	do	134	266	0.24	1.59	65
July	30	Farley Gannett	133	256	0.18	1.48	45
Nov.	4	H. P. Drake	133	275	0.24	1.67	67
1911							
June	22a	do	23	14	0.71	1.10	10

a. Wading measurement.

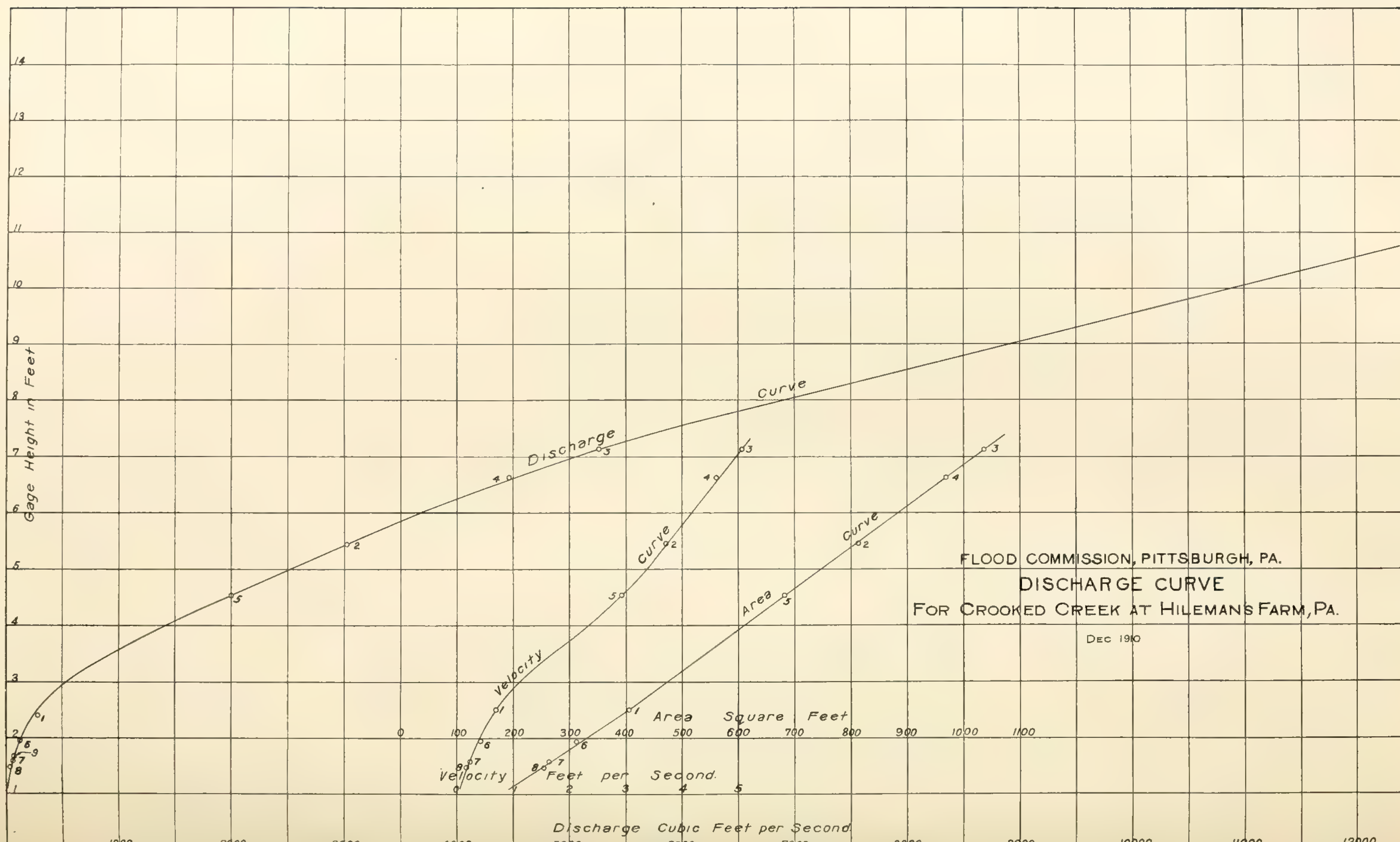
Rating Table for Crooked Creek at Hileman's Farm, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.60	0	2.40	246	4.20	1632	6.00	3686	7.80	6500
.70	2	.50	282	.30	1738	.10	3815	.90	6700
.80	4	.60	325	.40	1848	.20	3945	8.00	6900
.90	6	.70	374	.50	1960	.30	4075	.10	7100
1.00	8	.80	427	.60	2072	.40	4205	.20	7300
.10	10	.90	485	.70	2185	.50	4340	.30	7500
.20	20	3.00	547	.80	2298	.60	4480	.40	7700
.30	30	.10	615	.90	2412	.70	4620	.50	7900
.40	41	.20	689	5.00	2526	.80	4765	.60	8100
.50	53	.30	769	.10	2640	.90	4915	.70	8300
.60	66	.40	853	.20	2754	7.00	5065	.80	8500
.70	81	.50	940	.30	2868	.10	5225	.90	8700
.80	98	.60	1030	.40	2982	.20	5385	9.00	8900
.90	117	.70	1122	.50	3096	.30	5555	....	....
2.00	137	.80	1220	.60	3210	.40	5730	....	....
.10	160	.90	1318	.70	3324	.50	5910	....	....
.20	185	4.00	1420	.80	3440	.60	6100	....	....
.30	214	.10	1524	.90	3560	.70	6300	....	....

Daily Gage Heights and Discharges of Crooked Creek at Hileman's Farm, Pa., for 1909.

Day	October		Day	November		December		Day	November		December	
	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
16	1.30	30	1	1.25	25	1.15	15	17	1.28	28	1.80	98
17	1.15	15	2	1.10	10	1.25	25	18	1.10	10	1.55	60
18	1.15	15	3	1.15	15	1.10	10	19	1.22	22	1.35	36
19	1.18	18	4	1.10	10	1.10	10	20	1.20	20	1.15	15
20	1.15	15	5	1.25	25	1.15	15	21	1.32	32	1.35	36
21	1.18	18	6	1.18	18	1.25	25	22	1.22	22	1.40	41
22	1.10	10	7	1.22	22	1.25	25	23	1.25	25	1.25	25
23	1.22	22	8	1.18	18	1.20	20	24	1.25	25	1.35	36
24	1.22	22	9	1.15	15	1.25	25	25	1.32	32	1.15	15
25	1.30	30	10	1.22	22	1.15	15	26	1.22	22	1.15	15
26	1.50	53	11	1.25	25	1.20	20	27	1.22	22	1.20	20
27	1.25	25	12	1.10	10	1.15	15	28	1.30	30	1.25	25
28	1.10	10	13	1.22	22	1.45	47	29	1.25	25	1.15	15
29	1.15	15	14	1.25	25	3.40	853	30	1.25	25	1.20	20
30	1.10	10	15	1.15	15	2.85	456	31	....	..	1.25	25
31	1.20	20	16	1.15	15	1.85	108					

PLATE 98


FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR CROOKED CREEK AT HILEMAN'S FARM, PA.
DEC 1910
Discharge Curve
Velocity Curve
Area Curve
Gage Height in Feet
Discharge Cubic Feet per Second
Area Square Feet
Velocity Feet per Second.

Daily Gage Heights and Discharges of Crooked Creek at Hileman's Farm, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.65	74	....	....	b7.10	5225	1.50	53	1.71	83	1.61	68
2	1.85	108	....	....	6.15	3880	1.60	66	1.60	66	1.55	60
3	1.95	127	....	....	5.72	3347	1.55	60	1.68	73	1.65	74
4	2.25	200	....	....	4.80	2298	1.60	66	1.60	66	1.60	66
5	2.50	282	....	....	4.55	2016	1.61	68	1.71	83	1.55	60
6	2.85	456	....	....	4.55	2016	1.48	51	1.65	74	1.51	54
7	3.05	581	....	....	4.65	2128	1.40	41	1.60	66	1.56	61
8	....	...	....	....	3.60	1030	1.60	66	1.70	81	1.56	61
9	3.45	896	....	....	3.10	615	1.52	56	1.70	81	1.60	66
10	3.65	1076	....	....	2.80	427	1.31	31	1.51	54	1.36	37
11	3.85	1269	....	....	2.55	304	1.35	36	1.75	90	1.58	63
12	3.45	896	....	....	2.30	214	1.32	32	1.71	83	1.65	74
13	3.30	769	2.65	350	2.35	230	1.40	41	1.66	75	1.55	60
14	3.15	652	2.70	374	2.42	253	1.21	21	1.52	56	1.60	66
15	3.05	581	2.80	427	2.20	185	1.30	30	1.75	90	1.40	41
16	4.35	1793	4.20	1632	2.15	172	1.36	37	1.66	75	1.56	61
17	3.80	1220	4.75	2242	1.85	108	1.50	53	1.75	90	1.55	60
18	4.00	1420	4.60	2072	2.00	137	2.15	172	1.65	74	1.45	47
19	....	....	5.50	3096	2.00	137	2.25	200	1.90	117	1.60	66
20	....	....	5.50	3096	2.10	160	2.45	264	1.75	90	1.45	47
21	....	....	5.70	3324	1.88	113	3.36	819	2.30	214	1.50	53
22	....	....	5.20	2754	1.66	75	2.81	433	1.95	127	1.55	60
23	....	....	4.50	1960	1.80	98	2.35	230	2.00	137	1.42	43
24	....	....	4.05	1472	1.86	109	2.70	374	1.90	117	1.35	36
25	....	....	4.22	1653	1.98	133	3.51	949	1.80	98	1.20	20
26	....	....	5.15	2697	1.91	119	3.88	1298	1.81	100	1.50	53
27	....	....	5.45	3039	1.76	91	5.00	2526	1.85	107	1.55	60
28	....	....	a9.10	9110	1.80	98	4.81	2309	1.65	73	1.50	53
29	....	....	....	....	1.72	84	3.25	729	1.76	91	1.61	68
30	....	....	....	....	1.66	75	2.46	268	1.55	60	1.45	47
31	....	....	....	....	1.52	56	....	....	1.56	61	....	..

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.40	41	1.11	11	0.75	3	1.80	98	1.25	25	3.60	1030
2	1.25	25	1.05	8	0.80	4	1.45	47	1.25	25	3.00	547
3	1.35	36	1.16	16	0.95	7	1.65	73	1.50	53	2.35	230
4	1.30	30	1.30	30	2.65	350	1.55	60	1.75	89	1.85	107
5	1.20	20	1.20	20	2.75	400	1.40	41	1.65	73	1.95	127
6	1.10	10	1.10	10	1.95	127	1.50	53	1.40	41	1.80	98
7	1.35	36	1.15	15	1.85	108	1.50	53	1.55	60	1.90	117
8	1.70	81	1.15	15	3.40	853	1.45	47	1.60	66	1.85	107
9	1.65	73	1.20	20	3.20	689	1.75	89	1.45	47	1.80	98
10	1.31	31	1.05	8	2.45	264	1.60	66	1.40	41	1.90	117
11	1.35	36	1.25	25	1.70	81	1.55	60	1.45	47	1.65	73
12	1.45	47	1.15	15	1.15	15	1.65	73	1.60	66	1.65	73
13	1.35	36	1.05	9	1.00	8	1.90	117	1.40	41	1.70	81
14	1.65	73	0.95	7	0.85	5	1.80	98	1.55	60	1.70	81
15	1.80	98	0.85	5	0.95	7	1.65	73	1.50	53	1.85	107
16	1.70	81	0.80	4	0.80	4	1.55	60	1.60	66	1.80	98
17	1.35	36	0.75	3	0.95	7	1.40	41	1.40	41	1.80	98
18	1.40	41	0.85	5	1.85	107	1.45	47	1.50	53	2.25	200
19	1.55	60	0.70	2	1.75	89	1.55	60	1.45	47	2.30	214
20	1.65	73	0.85	5	1.85	107	1.65	73	1.45	47	2.25	200
21	1.80	98	0.70	2	1.80	98	1.45	47	1.60	66	2.50	282
22	1.90	117	0.80	4	1.95	127	1.50	53	1.65	73	2.90	485
23	1.85	107	0.70	2	2.35	230	1.20	20	1.65	73	3.25	729
24	1.15	15	0.75	3	3.15	652	1.35	35	1.80	98	4.00	1420
25	1.10	10	0.85	5	2.70	374	1.20	20	1.75	89	3.25	729
26	1.15	15	0.75	3	2.00	137	1.25	25	1.65	73	2.70	374
27	1.25	25	0.75	3	1.75	89	1.35	35	1.85	107	2.55	303
28	1.21	21	0.85	5	1.80	98	1.35	35	2.05	148	2.25	200
29	1.25	25	0.80	4	1.90	117	1.25	25	2.75	400	3.10	615
30	1.25	25	0.70	2	1.90	117	1.35	35	2.90	485	c7.00	5065
31	1.10	10	0.65	1	....	...	1.40	41	....	...	4.30	1738

a. Max. 5:30 P. M., 9.3 = 9500 sec.-ft.
b. Max. 7:30 A. M., 7.6 = 6100 sec.-ft.
c. Max. 7.5 = 5910 sec.-ft.
Gage carried away by ice January 19. Replaced February 13.

Daily Gage Heights and Discharges of Crooked Creek at Hileman's Farm, Pa., for 1911.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.34	803	3.59	1021	2.51	286	2.29	211	3.14	645	1.44	46	1.35	35	1.35	35	0.65	1
2	3.34	803	3.69	1113	2.73	390	2.44	260	2.99	541	1.34	34	1.55	59	1.55	59	0.65	1
3	2.94	510	2.74	395	2.84	450	2.34	227	2.49	278	1.34	34	1.35	35	1.60	66	0.85	5
4	2.84	450	2.64	345	2.54	299	2.34	227	2.44	260	1.54	58	1.15	15	1.25	25	0.85	5
5	2.54	299	2.64	345	2.54	299	2.64	345	2.34	227	1.49	52	1.25	25	1.15	15	0.90	6
6	2.34	227	2.74	395	2.74	395	3.04	574	2.29	211	1.34	34	1.40	41	1.20	20	3.00	547
7	2.14	170	2.89	479	2.64	345	3.34	803	2.44	260	1.64	72	1.15	15	1.35	35	2.45	264
8	2.24	197	2.89	479	2.44	260	3.64	1067	2.24	197	2.09	158	1.00	8	1.35	35	2.40	246
9	2.29	211	2.74	395	2.54	299	3.34	803	2.54	299	2.34	227	1.15	15	1.25	25	5.70	3324
10	2.29	211	2.64	345	2.74	395	3.29	761	2.74	395	2.74	395	1.10	10	1.30	30	3.85	1269
11	2.44	260	2.64	345	2.79	422	3.69	1113	2.44	260	3.04	574	1.35	35	1.15	15	1.90	117
12	2.99	541	2.44	260	2.44	260	3.44	888	2.44	260	2.94	510	1.40	41	1.20	20	1.65	73
13	4.44	1893	2.64	345	2.59	321	3.04	574	2.44	260	2.64	345	1.00	8	0.85	5	1.75	90
14	9.49	9880	2.84	450	2.74	395	2.89	479	2.34	227	2.54	299	0.95	7	0.75	3	a7.50	5910
15	7.84	6580	2.94	510	2.79	422	3.39	845	2.14	170	2.44	260	1.15	15	0.60	0	7.70	6300
16	5.59	3199	3.54	976	2.54	299	3.74	1161	1.84	106	2.44	260	1.15	15	0.75	3	4.30	1738
17	3.39	845	3.74	1161	2.54	299	3.54	976	2.04	146	2.69	369	1.00	8	0.85	5	2.40	246
18	2.94	510	3.69	1113	2.44	260	3.84	1259	1.74	88	1.74	88	0.85	5	0.65	1	1.80	98
19	2.64	345	3.24	721	2.34	227	3.64	1067	1.64	72	1.84	106	1.15	15	0.75	3	1.80	98
20	2.54	299	2.99	541	2.24	197	3.94	1359	1.84	106	1.79	96	1.40	41	0.75	3	1.65	73
21	2.59	321	2.79	422	2.39	243	4.09	1520	1.94	125	1.54	58	1.20	20	0.85	5	1.75	90
22	2.54	299	2.64	345	2.24	197	3.99	1410	1.74	88	1.34	34	1.55	59	0.85	5	2.15	172
23	2.69	369	2.74	395	2.34	227	3.74	1161	1.54	58	1.24	24	1.65	73	0.85	5	2.00	137
24	2.44	260	2.74	395	2.34	227	3.44	888	1.64	72	1.69	79	1.60	66	0.65	1	1.85	108
25	2.29	211	2.34	227	2.44	260	3.69	1113	1.74	88	1.79	96	1.50	53	0.75	3	1.80	98
26	2.44	260	2.59	321	2.24	197	3.79	1210	1.64	72	1.64	72	1.40	41	0.75	3	2.50	282
27	2.94	510	2.44	260	2.44	260	3.44	888	1.44	46	1.54	58	1.45	47	0.75	3	3.80	1220
28	5.34	2914	2.56	308	2.34	227	3.19	682	1.64	72	1.34	34	1.25	25	0.70	2	2.95	516
29	3.84	1259	....	...	2.34	227	3.34	803	1.74	88	1.14	14	1.15	15	0.65	1	2.50	282
30	3.49	931	....	...	2.44	260	3.49	931	1.64	72	1.09	9	1.45	47	0.75	3	2.00	137
31	2.99	541	....	...	2.24	197	....	....	1.64	72	....	..	1.40	41	0.70	2	....	...

a. Max. 5 P M., 10.6 = 12,100 sec.-ft.

Estimated Monthly Discharge of Crooked Creek at Hileman's Farm, Pa.

[Drainage area, 279 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
November	32	10	21	0.075	0.084
December	853	10	70	0.251	0.289
1910					
March	6100	56	837	3.000	3.459
April	2526	21	379	1.358	1.515
May	214	54	91	0.315	0.363
June	74	20	56	0.200	0.223
July	117	10	46	0.165	0.190
August	30	1	9	0.003	0.004
September	853	3	142	0.509	0.568
October	117	20	55	0.197	0.227
November	485	25	88	0.316	0.353
December	5910	73	508	1.821	2.099
10 months	6100	1	221	0.788	9.001
1911					
January	9880	170	1165	4.176	4.815
February	1161	260	521	1.864	1.941
March	450	197	287	1.029	1.186
April	1520	211	853	3.057	3.411
May	645	46	189	0.677	0.781
June	574	9	149	0.534	0.596
July	73	5	30	0.109	0.126
August	66	0	14	0.051	0.059
September	12100	1	782	2.803	3.127

MAHONING CREEK AT FURNACE BRIDGE, PA.

This station, situated at Furnace Bridge, Armstrong County, Pa., 2.5 miles above the mouth of Mahoning Creek, was established by K. C. Grant for the Water Supply Commission of Pennsylvania, and the Flood Commission of Pittsburgh, October 18, 1909. A staff gage originally placed here was carried away by ice January 19, 1910, and was replaced by a standard chain gage January 23, 1910. The zero of the chain gage is 0.36 foot above the zero of the staff gage. The length of the chain from marker to bottom of weight is 25.23 feet.

The upstream handrail, 20 feet from right bank, is 27.52 feet above the zero of the present gage. The stone bridge seat, upper end of right abutment, is 22.43 feet above the zero of the present gage.

Measurements are made from the downstream side of the bridge. The initial point for soundings is the top edge of the left abutment. At low water, measurements are made by wading just above the bridge.

The channel of the stream is straight for a distance of 800 feet above and 150 feet below the station. The bed of the stream is rocky and permanent. The velocity at low stages is very small. The right bank is high and is not subject to overflow, while the left bank overflows for a short distance at extremely high water. There is a range of about 14 feet between extreme high and extreme low water.

The gage is read once daily by J. D. Bechtel.

The drainage area above the station is 412 square miles.

Discharge Measurements of Mahoning Creek at Furnace Bridge, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1908			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Aug.	23	R. H. Bolster	...	....	....	a	99
Sept.	25	C. E. Ryder	...	....	....	a	20
1910							
Mar.	2	J. D. Stevenson	...	....	....	8.05	8330
Mar.	2	K. C. Grant	...	....	....	8.03	7859
Mar.	5	Victor Hammel	...	....	....	6.92	6160
May	10	H. P. Drake	148	336	0.98	2.48	323
May	26	do	148	328	0.94	2.42	295
June	30	C. E. Ryder	...	....	....	2.01	140
Sept.	27	H. P. Drake	148	565	2.39	3.99	1351
Nov.	7	C. E. Ryder	122	255	0.60	2.18	153
1911							
Jan.	17	J. T. Sykes	148	680	3.49	5.05	2370
Jan.	17	do	148	671	3.41	4.99	2284
June	23b	H. P. Drake	32	31	0.85	1.42	26

a. Measurement at mouth of creek. b. Wading measurement.

Note. Discharge curve and rating table for this station are provisional and are not given here.

Daily Gage Heights and Discharges of Mahoning Creek at Furnace Bridge, Pa., for 1909.

Day	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge	Day	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.04	7	....	....	17	....	....	....	....	4.16	1534
2	1.04	7	....	....	18	1.04	7	....	....	3.56	953
3	1.04	7	....	....	19	1.05	8	1.04	7	3.36	802
4	1.04	7	....	....	20	1.05	8	1.04	7	3.16	671
5	1.04	7	....	....	21	1.12	11	1.04	7	3.16	671
6	1.04	7	....	....	22	1.36	23	1.04	7	2.96	551
7	1.04	7	1.00	5	23	1.46	28	1.04	7	2.76	438
8	1.04	7	1.00	5	24	1.56	36	1.00	5	2.76	438
9	1.04	7	1.04	7	25	1.56	36	1.00	5	2.36	234
10	1.00	5	1.46	28	26	1.66	49	....	....	2.36	234
11	1.00	5	1.66	49	27	1.36	23	....	....	2.36	234
12	1.00	5	2.56	330	28	1.06	9	....	....	2.36	234
13	....	....	3.16	671	29	1.05	8	....	....	2.36	234
14	....	....	3.36	802	30	1.04	7	....	....	2.36	234
15	....	....	5.16	3027	31	1.04	7	....	....	2.36	234
16	....	....	4.76	2373							

Daily Gage Heights and Discharges of Mahoning Creek at Furnace Bridge, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.56	330	4.62	2160	9.99	11670	2.78	444	3.98	1335	2.57	335	1.96	110	1.16	13	1.56	36	a	500	2.16	163	3.75	1115
2	3.16	671	4.92	2628	8.59	9132	2.58	340	3.58	969	2.57	335	1.76	67	1.16	13	2.76	433	a	440	2.16	163	3.55	945
3	3.16	671	2.72	411	8.12	8286	2.58	340	3.18	683	2.37	238	1.66	49	1.16	13	3.56	953	a	380	2.26	196	3.55	945
4	3.16	671	2.82	467	8.29	8592	2.58	340	3.18	683	2.37	238	1.56	36	1.26	18	5.66	3895	a	320	2.26	196	3.35	795
5	3.16	671	3.12	647	8.19	8412	2.58	340	3.18	683	2.37	238	1.46	28	1.26	18	6.46	5305	a	260	2.16	163	3.05	605
6	3.16	671	4.02	1377	7.99	8052	2.48	290	3.08	623	2.37	238	1.46	28	1.16	13	5.96	4428	a	210	2.16	163	2.94	539
7	3.16	671	3.12	647	8.59	9132	2.48	290	2.98	563	2.37	238	1.46	28	1.16	13	4.96	2694	a	180	2.16	163	2.94	539
8	3.16	671	3.12	647	8.39	8772	2.48	290	2.98	563	2.37	238	1.36	23	1.16	13	4.46	1927	2.18	169	2.16	163	2.74	422
9	3.16	671	3.12	647	7.99	8052	2.48	290	2.88	503	2.37	238	1.56	36	1.16	13	3.96	1315	1.98	115	2.16	163	2.74	422
10	3.16	671	2.82	467	7.89	7872	2.38	242	2.78	444	2.27	199	1.66	49	1.16	13	2.96	551	1.78	70	2.26	196	2.44	270
11	3.16	671	2.82	467	7.29	6792	2.38	242	2.77	438	2.27	199	1.66	49	1.06	8	2.76	433	1.78	70	2.26	196	2.44	270
12	3.16	671	2.72	411	5.99	4482	2.38	242	2.37	238	2.37	238	1.56	36	1.06	8	2.46	280	1.78	70	2.26	196	2.34	226
13	3.16	671	2.82	467	5.99	4482	2.28	203	2.37	238	2.27	199	1.56	36	1.06	8	2.46	280	1.58	38	2.26	196	2.34	226
14	3.16	671	1.99	118	5.99	4482	2.28	203	2.27	199	2.17	166	1.46	28	0.96	3	2.16	163	1.58	38	2.16	163	2.14	157
15	3.56	953	3.39	823	5.79	4124	2.28	203	2.27	199	2.17	166	1.46	28	0.96	3	1.96	110	1.58	38	2.16	163	2.24	189
16	3.56	953	5.39	3423	5.59	3774	2.28	203	2.27	199	2.17	166	1.46	28	0.96	3	1.76	67	1.48	29	2.26	196	2.24	189
17	3.66	1036	6.39	5184	5.49	3424	2.28	203	2.37	238	2.17	166	1.46	28	0.96	3	1.56	36	1.48	29	2.26	196	2.24	189
18	6.16	4780	5.99	4482	5.49	3424	2.58	340	2.57	335	2.17	166	1.46	28	0.96	3	1.46	28	1.48	29	2.26	196	2.24	189
19	a	4700	4.59	2116	5.49	3424	2.78	444	2.97	557	2.17	166	1.46	28	1.26	18	1.46	28	1.48	29	2.26	196	3.14	659
20	a	3900	3.69	1062	4.99	2744	3.58	969	3.17	677	2.37	238	1.36	23	2.46	280	1.46	28	1.58	38	2.26	196	3.14	659
21	a	3100	3.39	823	4.99	2744	4.28	1680	3.17	677	2.57	335	1.36	23	1.76	67	1.46	28	1.88	91	2.25	192	3.34	788
22	a	2300	4.59	2116	4.59	2116	5.38	3405	3.57	961	2.77	438	1.36	23	1.56	36	1.26	18	1.98	115	2.25	192	3.44	860
23	4.62	2160	5.99	4482	4.59	2116	4.98	2727	3.57	961	2.77	438	1.36	23	1.56	36	1.26	18	2.28	203	2.55	325	3.93	1283
24	5.62	3824	5.39	3423	4.79	2420	4.58	2101	3.57	961	2.67	380	1.36	23	1.56	36	2.46	280	2.18	169	2.75	427	4.53	2027
25	5.12	2959	4.39	1826	4.59	2116	7.58	7314	3.77	1133	2.57	335	1.36	23	1.46	28	5.71	3982	2.18	169	2.95	545	4.43	1884
26	5.12	2959	3.99	1345	4.29	1693	8.68	9296	4.47	1941	2.57	335	1.36	23	1.46	28	5.96	4428	2.18	169	3.25	727	4.43	1884
27	5.12	2959	3.39	823	3.89	1246	7.48	7134	4.37	1800	2.57	335	1.36	23	1.46	28	5.36	3370	2.18	169	3.25	727	4.53	2027
28	5.12	2959	10.49	12570	3.59	977	6.48	5340	3.57	961	2.47	285	1.36	23	1.46	28	4.96	2494	2.38	242	3.55	945	4.73	2327
29	5.02	2793	.....	.....	3.39	823	5.38	3405	2.77	438	2.27	199	1.36	23	1.46	28	4.06	1421	2.38	242	3.75	1115	6.49	5358
30	4.32	1731	.....	.....	3.01	581	4.58	2101	2.57	335	2.17	166	1.36	23	1.36	23	a	600	2.28	203	3.75	1115	b7.97	8016
31	4.62	2160	.....	.....	2.99	569	....	....	2.57	335	....	...	1.36	23	1.36	23	....	...	2.28	203	....	....	6.45	5287

a. Estimated. b. Max. 3 P. M., 8.53 = 9023 sec.-ft.

Daily Gage Heights and Discharges of Mahoning Creek at Furnace Bridge, Pa., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.43	3495	6.22	4885	a3.50	905	3.41	837	2.90	515	1.50	30	1.50	30	1.40	25
2	5.73	4017	5.92	4356	a3.45	867	3.40	830	2.90	515	1.60	40	1.50	30	1.50	30
3	6.53	5429	5.12	2959	a3.30	760	3.90	1255	2.60	350	1.60	40	1.50	30	1.50	30
4	6.43	5252	4.22	1605	a3.25	727	4.40	1840	2.50	300	1.50	30	1.50	30	1.80	75
5	5.93	4374	3.92	1275	a3.20	695	4.50	1985	2.50	300	1.80	75	1.50	30	2.00	120
6	5.33	3317	3.92	1275	3.12	647	4.50	1985	2.50	300	2.20	175	1.50	30	2.20	175
7	4.73	2326	3.62	1002	3.22	706	4.70	2280	2.50	300	2.40	250	1.50	30	1.80	75
8	3.53	929	3.32	774	3.22	706	4.70	2280	2.20	175	2.10	145	a1.40	25	1.50	30
9	3.53	929	3.32	774	3.22	706	4.50	1985	2.00	120	1.50	30	a1.40	25	1.30	20
10	3.73	1097	3.22	706	3.22	706	4.10	1465	2.00	120	1.30	20	a1.40	25	1.20	15
11	4.73	2326	3.22	706	3.21	700	4.10	1465	2.00	120	1.30	20	a1.40	25	1.20	15
12	4.73	2326	3.22	706	3.21	700	4.30	1705	2.00	120	1.90	95	a1.40	25	1.10	10
13	5.93	4374	4.52	2014	3.51	913	4.30	1705	2.00	120	2.10	145	1.40	25	1.10	10
14	7.83	7764	4.92	2628	4.01	1366	4.50	1985	2.00	120	1.70	55	1.30	20	1.10	10
15	9.08	10014	5.12	2959	4.51	2000	4.70	2280	2.00	120	1.70	55	1.30	20	1.20	15
16	7.43	7044	5.22	3129	4.51	2000	4.50	1985	1.90	95	1.50	30	1.30	20	1.20	15
17	6.93	6144	5.32	3300	4.21	1592	4.30	1705	1.90	95	1.50	30	1.20	15	1.40	25
18	6.23	4902	5.52	3650	3.91	1265	4.30	1705	1.90	95	1.50	30	1.40	25	1.50	30
19	5.33	3317	6.12	4710	3.71	1079	4.50	1985	1.90	95	1.40	25	1.40	25	1.60	40
20	4.23	1617	5.92	4356	3.51	913	4.70	2280	1.90	95	1.50	30	1.30	20	1.50	30
21	3.52	921	5.52	3650	3.51	913	4.90	2595	1.90	95	1.50	30	1.20	15	1.50	30
22	3.42	845	4.92	2628	3.71	1079	5.70	3965	1.90	95	1.40	25	1.20	15	1.30	20
23	3.42	845	4.52	2014	3.91	1265	5.50	3615	1.90	95	1.40	25	1.20	15	1.40	25
24	3.42	845	4.52	2014	4.11	1476	5.30	3265	1.70	55	1.50	30	1.20	15	2.70	400
25	3.52	921	4.22	1605	3.71	1079	4.90	2595	1.50	30	1.50	30	1.20	15	2.60	350
26	3.72	1088	4.22	1605	3.31	767	4.50	1985	1.50	30	2.40	250	1.20	15	2.40	250
27	4.52	2014	3.92	1275	3.31	767	4.10	1465	1.30	20	2.00	120	1.10	10	2.40	250
28	7.32	6846	a3.80	1160	3.21	700	3.90	1225	1.30	20	1.80	75	1.10	10	2.40	250
29	5.92	4356	....	....	3.21	700	3.70	1070	1.30	20	1.60	40	1.10	10	2.80	455
30	5.32	3300	....	....	3.31	767	3.30	760	1.50	30	1.50	30	1.10	10	3.60	985
31	4.92	2628	....	....	3.41	837	....	...	1.50	30	....	..	1.10	10	4.40	1840

a. Interpolated.

Estimated Monthly Discharge of Mahoning Creek at Furnace Bridge, Pa.

[Drainage area, 412 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	4780	330	1783	4.328	4.990
February	12570	118	2002	4.859	5.060
March	11670	569	4727	11.475	13.233
April	9296	203	1699	4.124	4.601
May	1941	199	673	1.633	1.883
June	438	166	255	0.619	0.691
July	110	23	33	0.080	0.092
August	280	3	27	0.066	0.076
September	5305	18	1321	3.206	3.577
October	500	29	162	0.394	0.454
November	1115	163	331	0.803	0.896
December	9023	157	1332	4.204	4.847
The year	12570	3	1195	2.982	40.400
1911					
January	10014	845	3407	8.269	9.533
February	4885	706	2276	5.524	5.752
March	2000	700	978	2.859	3.338
April	3965	760	1936	4.699	5.243
May	515	20	148	0.359	0.414
June	250	20	67	0.162	0.181
July	30	10	21	0.050	0.058
August	1840	10	182	0.442	0.510

RED BANK CREEK AT ST. CHARLES, PA.

This station, situated on the wooden bridge at St. Charles, Clarion Co., Pa., 15 miles above the mouth, was established October 19, 1909, by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh.

A standard chain gage, measuring 24.55 feet from low-water marker to bottom of weight, and 14.55 feet from high-water marker to bottom of weight, is installed at this station. The upstream corner of the right bridge seat is 19.37 feet above the zero of the gage. The wooden stringer under the pulley of the gage is 21.67 feet above the zero of the gage.

The initial point for soundings is at the right abutment, on the upstream side of the bridge. Low-water measurements are taken by wading, about 200 yards above the bridge.

The channel is straight for but a very short distance above and below the station. The bed of the stream is composed of large rocks and is of a permanent character. The right bank overflows at extremely high stages, while the left bank is high and does not overflow. There is a range of about 14 feet between extreme high and extreme low water.

The gage is read twice daily by W. H. Bish.

The drainage area above the station is 540 square miles.

Discharge Measurements of Red Bank Creek at St. Charles, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1910							
Mar.	4	V. F. Hammel	136	994	7.75	7.10	7697
Mar.	4	do	136	994	7.58	7.11	7539
May	26	H. P. Drake	130	400	1.47	2.73	559
July	30	Farley Gannett	...	140	0.25	1.16	35
Aug.	10a	H. P. Drake	49	23	0.50	0.89	13
Sept.	27	do	136	491	3.13	3.43	1536
Nov.	7	C. E. Ryder	120	273	0.87	1.95	238
1911							
Jan.	14	J. T. Sykes	136	1182	10.20	8.04	12042
Jan.	14	do	136	1207	10.32	8.07	12460
Jan.	15	do	136	1165	8.93	7.92	10395
Jan.	15	do	136	1125	8.55	7.62	9600
Jan.	16	do	136	847	6.43	5.73	5448
June	22a	H. P. Drake	52	70	1.05	1.46	74

a. Wading measurement.

Daily Gage Heights, in Feet, of Red Bank Creek at St. Charles, Pa.

Day	1909 Nov.	1909 Dec.	1910 Jan.	1910 Feb.	1910 March	1910 April	1910 May	1910 June
1	1.03	1.22	*1.61	2.60	8.66	2.36	3.05	2.11
2	0.93	1.18	*2.29	2.33	8.46	2.19	2.84	2.16
3	0.95	1.16	*3.73	2.53	8.21	2.10	2.69	2.43
4	0.89	0.99	*3.73	2.65	7.34	2.46	2.62	2.54
5	0.91	0.96	*3.63	2.57	6.75	3.40	2.52	2.29
6	0.89	1.02	*4.03	2.40	7.05	3.15	2.34	2.24
7	0.89	1.02	*3.98	2.09	7.90	2.72	2.22	2.20
8	1.03	a1.04	*4.33	2.26	6.25	2.49	2.18	2.10
9	0.86	a1.06	*4.08	2.40	5.00	2.37	2.15	2.02
10	0.87	a1.14	*3.78	2.36	4.40	2.27	2.18	2.05
11	0.88	a1.06	*3.58	2.17	4.00	*2.20	2.09	2.11
12	0.89	a1.03	*3.43	2.12	3.65	*2.20	2.00	2.18
13	0.89	a1.24	*3.43	2.07	3.55	*2.20	1.85	2.08
14	0.89	2.26	*3.33	2.11	3.25	*2.20	1.84	1.99
15	1.00	2.56	*3.33	2.13	3.25	*2.10	1.82	1.84
16	0.97	2.18	*3.23	2.82	3.10	*2.10	1.80	1.86
17	1.06	1.98	*3.23	3.91	3.15	*2.10	1.72	1.74
18	1.03	1.74	b7.06	3.71	3.00	*2.40	1.84	1.74
19	0.99	2.52	7.13	3.33	3.05	*2.70	1.90	1.84
20	1.27	a2.96	5.83	3.06	3.60	2.90	1.84	1.76
21	1.09	a3.24	6.13	3.36	4.05	3.45	2.06	1.69
22	1.27	a3.08	6.38	4.19	3.90	3.50	2.76	1.59
23	1.35	a2.93	5.33	3.91	3.65	3.15	2.76	1.49
24	1.55	a2.72	4.58	3.31	3.55	3.10	2.58	1.69
25	1.49	a2.73	3.83	3.16	3.55	d5.49	2.78	1.76
26	1.39	a2.44	3.33	3.03	3.40	5.45	2.72	1.18
27	1.31	a2.31	3.68	3.56	2.95	4.70	2.50	1.20
28	1.18	a2.62	3.33	c10.26	2.78	3.90	2.20	1.50
29	1.25	a2.53	3.18	---	2.60	3.55	2.15	1.52
30	1.27	a2.50	2.91	---	2.60	3.35	2.16	1.38
31	---	a1.86	2.78	---	2.46	---	2.18	---

Day	1910 July	1910 Aug.	1910 Sept.	1910 Oct.	1910 Nov.	1910 Dec.
1	1.37	1.24	1.29	2.17	1.77	3.37
2	1.35	1.27	1.19	1.99	1.84	3.00
3	1.09	1.37	1.52	1.88	2.14	2.81
4	1.39	1.13	4.67	1.77	2.17	2.73
5	1.28	0.97	3.35	1.69	2.03	2.44
6	1.29	0.95	2.72	1.71	1.95	2.50
7	1.21	0.93	2.29	1.95	1.93	2.17
8	1.28	1.07	1.97	1.88	1.83	2.10
9	1.57	0.91	1.75	1.74	1.87	2.25
10	1.37	1.01	1.69	1.80	1.87	2.09
11	1.49	1.10	1.43	1.65	2.06	2.00
12	1.44	1.08	1.65	1.57	2.35	2.09
13	1.40	1.19	1.48	1.58	2.30	2.05
14	1.04	1.13	1.37	1.55	2.19	2.05
15	1.31	1.34	1.45	1.55	2.35	2.10
16	1.14	1.28	1.36	1.55	2.41	2.11
17	2.14	1.10	1.28	1.52	2.47	2.13
18	1.69	1.20	1.01	1.18	2.47	2.20
19	1.73	1.90	1.41	1.40	2.37	2.15
20	1.54	1.40	1.36	1.37	2.26	2.15
21	1.39	1.33	1.38	1.37	2.27	2.27
22	1.38	1.33	1.35	1.70	2.31	2.17
23	1.23	1.30	1.16	1.88	2.33	2.23
24	1.11	1.16	2.74	1.71	2.65	2.27
25	1.39	1.16	5.16	1.85	3.15	2.47
26	1.35	1.58	4.51	1.86	3.27	2.28
27	1.14	1.57	3.52	1.93	3.06	2.15
28	1.34	1.38	3.06	2.05	2.83	2.20
29	1.33	1.44	2.61	2.05	3.75	3.93
30	1.11	1.33	2.34	1.91	3.43	7.66
31	0.94	1.26	---	1.83	---	5.65

Day	1911 Jan.	1911 Feb.	1911 March	1911 April	1911 May	1911 June	1911 July	1911 Aug.	1911 Sept.	1911 Oct.	1911 Nov.	1911 Dec.
1	4.79	3.55	2.87	3.46	3.05	1.52	1.35	1.15	3.62	5.50	2.50	2.85
2	5.29	3.38	2.32	3.31	3.15	1.51	1.42	1.15	3.48	13.45	2.58	2.95
3	6.36	3.08	2.97	3.16	3.30	1.52	1.32	1.45	2.55	6.75	2.48	3.45
4	5.09	3.08	2.97	2.96	2.79	1.51	1.30	1.45	2.47	6.15	2.40	3.32
5	4.04	3.21	2.47	3.11	2.60	1.49	1.70	2.33	7.70	5.15	2.35	3.22
6	3.51	2.83	2.57	4.06	2.42	1.44	1.10	2.37	6.67	4.10	2.22	3.00
7	3.54	2.51	2.47	4.31	2.40	1.41	1.22	2.25	4.78	5.75	3.25	2.88
8	3.29	2.58	2.07	4.11	2.35	1.47	1.53	1.90	4.00	4.78	3.45	2.78
9	3.19	2.63	2.50	3.86	2.15	1.39	1.52	1.82	3.47	4.55	2.95	3.30
10	2.64	2.51	2.81	4.36	2.22	1.44	1.53	1.62	3.38	4.38	2.82	4.10
11	2.99	2.13	3.20	3.91	2.15	1.37	1.32	1.68	3.55	3.55	2.78	4.25
12	4.99	2.21	3.17	3.36	2.18	1.52	1.33	1.57	3.50	3.38	2.80	4.35
13	5.94	2.61	3.47	3.56	2.12	1.64	1.42	1.53	3.72	3.15	3.70	6.70
14	7.69	2.66	3.37	3.46	2.00	1.62	1.38	1.55	3.65	3.05	3.65	6.85
15	7.62	4.65	3.20	4.96	1.93	1.57	1.47	1.57	9.22	3.22	3.30	6.10
16	6.24	3.83	2.85	4.06	1.95	1.49	1.53	1.53	8.15	3.38	3.28	5.45
17	4.76	3.68	3.22	3.96	1.93	1.57	1.52	2.55	6.15	3.10	3.22	6.25
18	3.77	5.78	3.27	3.73	1.82	1.34	1.63	2.42	5.10	6.90	5.25	5.45
19	3.39	5.38	3.37	3.49	1.77	1.52	1.07	1.73	3.70	5.20	5.35	5.15
20	3.14	4.38	3.47	4.01	1.55	1.51	1.17	1.67	3.35	4.22	4.90	4.75
21	3.02	3.63	3.47	4.59	1.50	1.42	1.08	1.47	3.12	4.00	4.10	4.50
22	3.06	3.43	3.32	4.19	1.72	1.31	1.12	1.62	2.95	3.92	3.65	3.95
23	2.79	3.28	3.47	3.66	1.55	1.31	1.47	1.63	2.77	3.48	3.40	3.75
24	2.39	2.75	3.32	4.06	1.55	1.38	1.52	1.55	2.47	3.25	4.00	3.95
25	2.14	2.78	3.07	4.76	1.52	1.35	1.48	1.65	2.35	2.92	4.50	3.85
26	2.62	3.03	2.97	4.66	1.45	1.62	1.43	1.95	2.20	2.75	3.70	3.60
27	2.60	3.65	3.14	4.28	1.48	1.53	1.47	2.45	2.12	2.75	3.60	4.15
28	5.76	3.33	3.57	2.96	1.38	1.40	1.43	4.75	4.98	2.62	3.40	3.75
29	4.77	---	3.42	2.86	1.48	1.35	1.35	7.72	4.85	2.48	3.55	3.58
30	4.84	---	3.40	2.76	1.35	1.32	1.37	6.60	4.82	2.45	3.50	3.38
31	4.09	---	3.47	---	1.52	---	1.28	4.50	---	2.50	---	4.35

a. Creek frozen. * Interpolated. b. Maximum 10.03. c. Maximum 10.51 at 5 P. M. d. Maximum 6.00 at 5 P. M.

Creek frozen Jan. 1-17, 1910, inclusive. Gage heights interpolated April 11-19, 1910, inclusive.

No estimates of daily or monthly discharge are published, as a satisfactory rating table for this station cannot be computed until additional discharge measurements are made.

CLARION RIVER AT CLARION, PA.

This station is located at the county steel bridge over the Clarion River, 32 miles above the mouth, near Clarion, Clarion County, Pa. The U. S. Weather Bureau established a station for recording gage heights at this point in 1884. The gage consisted of a scale painted on a nearby ledge of rock, and divided into feet and half feet. These readings were discontinued in 1895.

In 1901 the Weather Bureau established a second gage, the stages below 5 feet being read on a scale painted on a sloping ledge of rock, and between 5 and 14 feet, on a scale chiseled in the face of the right abutment. This gage was replaced in 1909, by a Mott steel tape gage, which is in use at present. All these gages have the same datum, the zero being 25.6 feet below the top of the right abutment, which has an elevation of 1,077.6.

Discharge measurements were begun at this station on March 20, 1908, by K. C. Grant, for the Water Supply Commission of Pennsylvania. Measurements are taken from the downstream side of the bridge. The channel is straight for a distance of 500 feet above and below the bridge, and has a permanent bed composed of gravel and rock. Both banks are high and do not overflow. The greatest range of gage heights is about 17 feet.

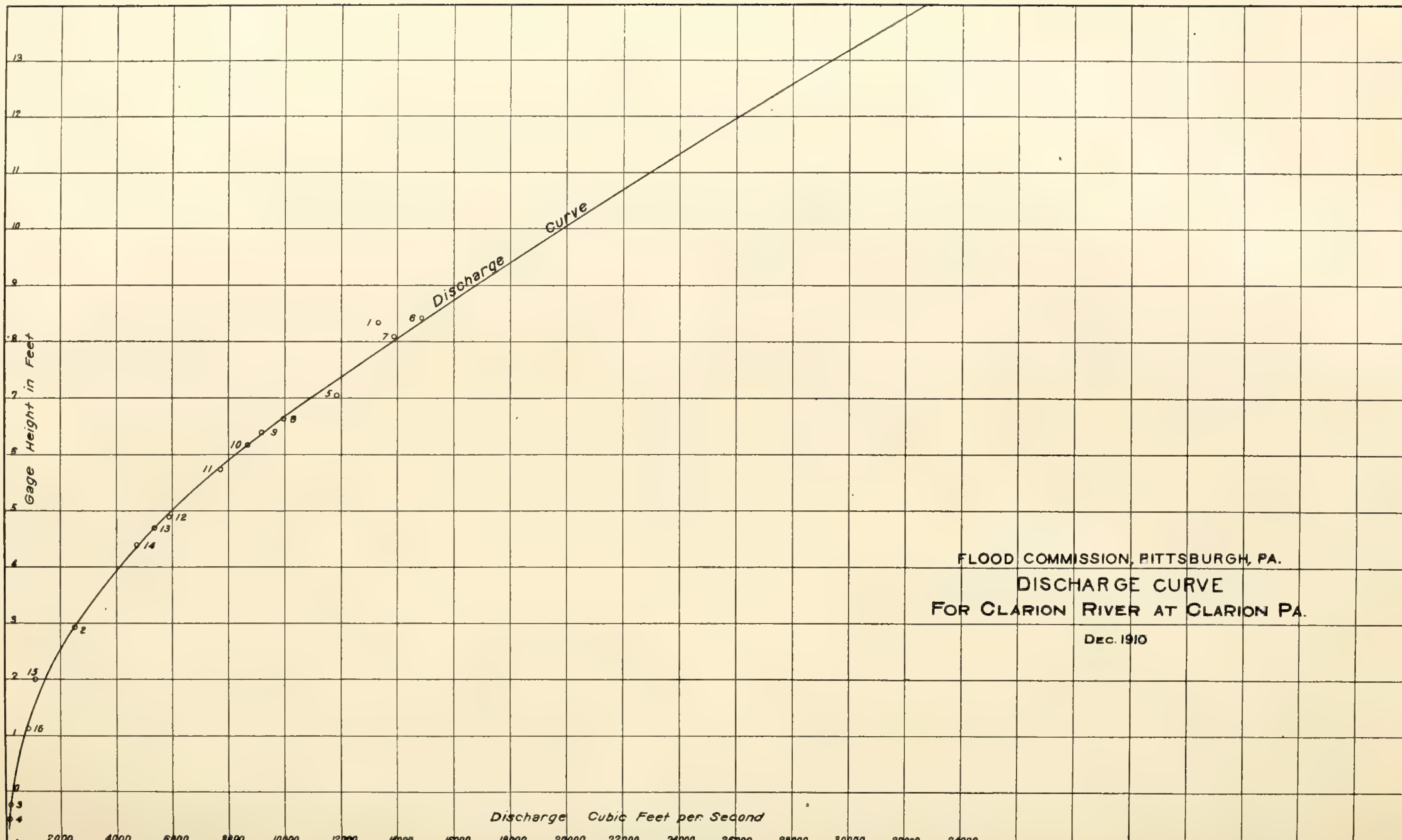
The gage is read daily by J. A. Miller.

The drainage area above the station is 910 square miles.

Discharge Measurements of Clarion River at Clarion, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1908			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Mar.	20	K. C. Grant	198	2036	6.53	8.35	13298
May	15	do	149	937	2.64	2.92	2480
Aug.	24	R. H. Bolster	130	391	0.39	-0.26	154
Sept.	26	C. E. Ryder	...	...	....	-0.50	120
1909							
Feb.	25	J. D. Stevenson	198	1867	6.34	7.05	11839
May	2	C. E. Ryder	196	1952	7.59	8.43	14821
May	2	do	196	1897	7.30	8.10	13854
May	3	do	196	1619	6.15	6.65	9964
May	3	do	196	1569	5.83	6.40	9149
May	3	do	195	1533	5.64	6.18	8647
May	4	do	194	1412	5.43	5.73	7671
May	5	do	177	1272	4.67	4.90	5843
May	5	do	177	1235	4.35	4.70	5380
May	6	do	176	1180	3.99	4.40	4710
1910							
May	27	H. P. Drake	176	773	1.46	2.00	1068
June	17	do	174	645	1.25	1.12	804
1911							
Oct.	24	C. E. Ryder	143	787	1.87	2.06	1470

Note. Rating table will be found on page 164.


FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR CLARION RIVER AT CLARION PA.
DEC. 1910
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
24000
26000
28000
30000
32000
34000

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1885.

Day	January		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.50	7010	....	....	3.50	3280	4.40	4795	0.80	545	0.30	320	3.00	2550	0.40	360	1.70	1160	1.70	1160
2	5.00	5930	....	....	3.70	3590	4.20	4435	0.70	490	0.20	280	2.90	2415	0.30	320	1.80	1240	1.60	1080
3	3.00	2550	5.50	7010	3.60	3435	3.50	3280	0.70	490	0.70	490	2.50	1930	0.60	440	2.10	1505	1.60	1080
4	2.70	2160	6.20	8730	3.40	3125	2.60	2040	0.60	440	10.30	20730	1.60	1080	0.40	360	2.00	1415	1.50	1005
5	2.40	1820	6.00	8215	2.90	2415	2.80	2285	0.60	440	5.30	6560	2.40	1820	0.50	400	1.90	1325	1.50	1005
6	2.40	1820	5.50	7010	2.80	2285	9.60	18600	0.60	440	3.90	3920	3.00	2550	0.50	400	1.90	1325	1.50	1005
7	3.90	3920	5.60	7240	2.80	2285	5.80	7715	0.40	360	3.00	2550	2.50	1930	0.70	490	2.00	1415	1.40	935
8	4.80	5540	5.70	7475	3.10	2690	7.70	12930	0.30	320	3.00	2550	2.00	1415	0.50	400	1.90	1325	1.30	860
9	4.00	4090	7.00	10900	3.80	3750	6.70	10060	0.20	280	2.70	2160	4.20	4435	0.50	400	1.90	1325	2.30	1710
10	3.40	3125	5.80	7715	3.10	2690	5.00	5930	0.20	280	2.40	1820	5.00	5930	0.50	400	2.10	1505	3.20	2830
11	3.00	2550	4.80	5540	2.90	2415	3.90	3920	0.60	440	2.20	1605	3.50	3280	0.40	360	2.00	1415	3.30	2975
12	3.40	3125	4.20	4435	2.80	2285	3.50	3280	1.70	1160	2.00	1415	3.20	2830	0.40	360	1.90	1325	2.80	2285
13	5.20	6340	3.80	3750	2.70	2160	3.20	2830	1.30	860	1.90	1325	3.00	2550	0.50	400	1.80	1240	2.60	2040
14	4.00	4090	3.00	2550	2.70	2160	2.90	2415	1.70	1160	10.80	22280	2.70	2160	1.70	1160	1.70	1160	3.00	2550
15	3.40	3125	2.80	2285	2.60	2040	2.50	1930	2.50	1930	6.20	8730	2.00	1415	4.00	4090	1.70	1160	3.30	2975
16	3.00	2550	2.90	2415	2.30	1710	2.50	1930	1.90	1325	4.30	4615	1.80	1240	2.80	2285	1.60	1080	2.90	2415
17	5.60	7240	3.00	2550	2.00	1415	2.00	1415	1.30	860	3.60	3435	1.50	1005	2.20	1605	1.50	1005	2.80	2285
18	6.40	9255	3.80	3750	1.90	1325	1.80	1240	0.80	545	3.10	2690	1.30	860	2.00	1415	1.50	1005	2.70	2160
19	4.00	4090	4.40	4795	1.60	1080	1.80	1240	0.60	440	2.80	2285	1.20	790	1.50	1005	1.80	1240	2.60	2040
20	3.00	2550	5.00	5930	1.40	935	1.60	1080	0.50	400	5.30	6560	1.10	720	1.90	1325	3.20	2830	2.50	1930
21	2.50	1930	5.90	7965	2.60	2040	1.20	790	0.30	320	3.70	3590	1.00	660	1.30	860	3.30	2975	2.40	1820
22	2.20	1605	6.00	8215	2.80	2285	1.30	860	0.20	280	3.00	2550	0.80	545	3.00	2550	2.40	1820	2.40	1820
23	2.10	1505	6.30	8990	2.90	2415	1.60	1080	0.20	280	4.00	4090	0.80	545	2.50	1930	2.00	1415	2.60	2040
24	1.90	1325	5.90	7965	2.70	2160	1.30	860	0.70	490	3.70	3590	1.40	935	2.00	1415	2.00	1415	3.00	2550
25	1.90	1325	5.40	6780	7.50	12350	1.50	1005	1.00	660	4.70	5350	1.20	790	1.70	1160	2.90	2415	3.00	2550
26	1.90	1325	4.80	5540	3.10	2690	1.00	660	0.70	490	8.60	15600	1.00	660	1.60	1080	2.30	1710	2.80	2285
27	....	....	6.50	9520	4.20	4435	0.70	490	1.40	935	6.00	8215	0.80	545	1.60	1080	2.10	1505	2.70	2160
28	....	....	4.90	5730	3.60	3435	0.60	440	1.20	790	4.80	5540	0.70	490	1.60	1080	1.90	1325	2.70	2160
29	....	....	4.20	4435	3.00	2550	0.80	545	0.70	490	3.80	3750	0.60	440	1.70	1160	1.80	1240	2.60	2040
30	....	....	4.10	4260	2.90	2415	0.90	600	0.50	400	3.00	2550	0.50	400	1.90	1325	1.80	1240	2.60	2040
31	....	....	....	....	3.80	3750	....	...	0.40	360	3.70	3590	....	...	1.90	1325	....	....	2.70	2160

Note. No record February and March.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1886.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.70	2160	....	....	2.50	1930	9.80	19200	1.70	1160	0.60	440
2	2.70	2160	....	....	2.30	1710	7.00	10900	1.70	1160	0.60	440
3	2.70	2160	....	....	....	....	5.70	7475	1.70	1160	0.60	440
4	3.50	3280	....	....	....	....	5.30	6560	1.60	1080	0.50	400
5	12.50	27750	....	....	....	....	4.30	4615	1.60	1080	0.50	400
6	8.80	16200	....	....	....	....	4.90	5720	1.60	1080	0.40	360
7	5.50	7010	....	....	....	....	8.70	15900	1.60	1080	0.40	360
8	4.40	4795	....	....	....	....	6.20	8730	1.70	1160	0.40	360
9	4.00	4090	....	....	....	....	5.00	5930	1.70	1160	0.40	360
10	3.50	3280	....	....	....	....	5.00	5930	1.70	1160	0.30	320
11	3.10	2690	....	....	....	....	4.80	5540	1.90	1325	0.20	280
12	....	....	....	....	....	....	4.60	5165	1.80	1240	0.00	220
13	....	....	....	....	....	....	4.70	5350	1.60	1080	-0.10	190
14	....	....	7.20	11480	....	....	4.40	4795	1.50	1005	0.00	220
15	....	....	6.30	8990	....	....	4.00	4090	1.50	1005	0.00	220
16	....	....	5.40	6780	....	....	3.40	3125	1.40	935	-0.10	190
17	....	....	4.10	4260	2.40	1820	3.20	2830	1.40	935	0.50	400
18	....	....	3.40	3125	2.60	2040	2.60	2040	1.40	935	1.20	790
19	....	....	3.20	2830	2.90	2415	2.40	1820	1.30	860	0.90	600
20	....	....	2.90	2415	3.50	3280	2.00	1415	1.10	720	0.70	490
21	....	....	2.90	2415	5.30	6560	1.80	1240	1.10	720	0.60	440
22	....	....	2.80	2285	7.80	13220	1.60	1080	0.90	600	0.50	400
23	....	....	2.70	2160	6.40	9255	1.50	1005	0.90	600	0.60	440
24	....	....	2.60	2040	4.80	5540	1.50	1005	0.90	600	0.70	490
25	....	....	2.60	2040	4.30	4615	1.50	1005	0.90	600	0.60	440
26	....	....	2.90	2415	4.40	4795	1.50	1005	0.80	545	0.90	600
27	....	....	2.80	2285	4.60	5165	1.80	1240	0.90	600	2.10	1505
28	....	....	2.60	2040	4.30	4615	1.50	1005	0.90	600	1.00	660
29	....	....	....	....	4.00	4090	2.00	1415	0.70	490	0.60	440
30	....	....	....	....	4.20	4435	1.80	1240	0.60	440	0.40	360
31	....	....	....	....	4.40	4795	....	....	0.60	440	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.30	320	0.00	220	-0.50	120	2.20	1605	-0.60	110	3.00	2550
2	0.10	250	0.00	220	0.70	490	1.80	1240	-0.60	110	2.40	1820
3	-0.10	190	-0.20	165	0.50	400	1.30	860	-0.60	110	1.80	1240
4	-0.10	190	-0.20	165	0.00	220	0.90	600	-0.60	110	1.20	790
5	-0.10	190	-0.20	165	-0.10	190	0.50	400	-0.60	110	1.20	790
6	-0.20	165	-0.30	145	-0.30	145	0.30	320	-0.60	110	1.20	790
7	-0.20	165	-0.30	145	-0.40	130	0.30	320	-0.60	110	....	...
8	-0.20	165	-0.30	145	-0.50	120	0.10	250	-0.60	110	....	...
9	-0.20	165	-0.30	145	-0.50	120	0.00	220	-0.60	110	....	...
10	-0.20	165	-0.30	145	-0.60	110	0.00	220	-0.60	110	....	...
11	-0.20	165	-0.30	145	-0.60	110	-0.10	190	-0.40	130	....	...
12	-0.20	165	-0.30	145	-0.60	110	-0.20	165	-0.30	145	....	...
13	-0.20	165	-0.30	145	-0.40	130	-0.40	130	0.50	400	....	...
14	0.10	250	-0.30	145	-0.40	130	-0.40	130	0.60	440	....	...
15	1.10	720	-0.40	130	-0.50	120	-0.30	145	0.60	440	3.00	2550
16	1.30	860	-0.40	130	-0.40	130	-0.50	120	0.50	400	2.60	2040
17	1.30	860	-0.40	130	-0.30	145	-0.50	120	0.60	440	2.20	1605
18	1.00	660	-0.40	130	-0.30	145	-0.50	120	4.80	5540	2.00	1415
19	0.90	600	-0.50	120	0.60	440	-0.50	120	7.50	12350	2.00	1415
20	0.70	490	-0.50	120	0.80	545	-0.50	120	4.80	5540	2.00	1415
21	0.50	400	-0.50	120	2.00	1415	-0.50	120	3.80	3750	1.70	1160
22	0.30	320	-0.50	120	1.30	860	-0.60	110	3.00	2550	1.70	1160
23	0.20	280	-0.50	120	0.80	545	-0.60	110	3.20	2830	1.60	1080
24	0.00	220	-0.40	130	0.60	440	-0.60	110	8.90	16500	1.60	1080
25	-0.10	190	-0.50	120	0.50	400	-0.60	110	5.00	5930	2.80	2285
26	-0.20	165	-0.50	120	0.50	400	-0.60	110	4.60	5165	2.00	1415
27	1.70	1160	-0.50	120	0.60	440	-0.60	110	4.40	4795	1.90	1325
28	0.50	400	-0.50	120	1.00	660	-0.50	120	4.00	4090	1.90	1325
29	0.50	400	-0.50	120	2.90	2415	-0.50	120	3.80	3750	1.70	1160
30	0.20	280	-0.50	120	3.20	2830	-0.50	120	3.80	3750	1.70	1160
31	0.10	250	-0.50	120	....	....	-0.50	120	....	....	1.70	1160

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1887.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.70	1160	2.50	1930	3.90	3920	1.40	935	3.80	3750
2	1.70	1160	2.50	1930	3.40	3125	1.30	860	3.40	3125
3	1.60	1080	2.90	2415	3.10	2690	1.20	790	3.30	2975
4	1.50	1005	3.20	2830	3.80	3750	1.20	790	3.00	2550
5	....	....	2.50	1930	3.40	3125	1.20	790	2.80	2285
6	....	....	2.30	1710	5.60	7240	2.30	1710	2.60	2040
7	....	....	2.60	2040	6.60	9790	2.00	1415	2.50	1930
8	....	....	9.60	18600	6.10	8470	1.90	1325	3.30	2975
9	....	....	10.50	21350	5.90	7965	1.70	1160	4.00	4090
10	....	....	9.50	18300	5.60	7240	1.60	1080	4.20	4435
11	....	....	9.20	17400	5.20	6340	1.60	1080	4.60	5165
12	....	....	12.00	26100	4.80	5540	3.00	2550	4.30	4615
13	....	....	7.20	11480	4.40	4795	3.40	3125	3.90	3920
14	....	....	5.70	7475	4.10	4260	3.40	3125	3.40	3125
15	....	....	5.30	6560	3.80	3750	3.10	2690	3.20	2830
16	....	....	5.40	6780	3.50	3280	2.80	2285	2.90	2415
17	....	....	4.90	5730	3.20	2830	4.50	4980	2.50	1930
18	....	....	4.70	5350	2.70	2160	3.40	3125	2.20	1605
19	....	....	6.70	10060	2.40	1820	3.20	2830	1.90	1325
20	....	....	5.70	7475	2.40	1820	3.00	2550	1.70	1160
21	....	....	4.90	5730	2.30	1710	2.80	2285	1.60	1080
22	....	....	4.60	5165	2.20	1605	2.80	2285	1.50	1005
23	....	....	4.30	4615	2.00	1415	4.50	4980	1.40	935
24	....	....	4.90	5730	2.00	1415	4.70	5350	1.30	860
25	4.00	4090	5.20	6340	1.80	1240	3.80	3750	1.40	935
26	4.00	4090	4.60	5165	1.70	1160	3.20	2830	1.80	1240
27	3.80	3750	4.90	5730	1.60	1080	3.00	2550	1.80	1240
28	3.00	2550	4.40	4795	1.60	1080	2.80	2285	1.50	1005
29	3.00	2550	....	....	1.50	1005	3.40	3125	1.40	935
30	3.00	2550	....	....	1.50	1005	4.20	4435	1.30	860
31	2.70	2160	....	....	1.40	935	....	....	1.30	860

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	-0.30	145	0.80	545	0.10	250	0.10	250	-0.60	110	0.80	545
2	-0.40	130	0.60	440	0.00	220	0.10	250	-0.60	110	....	...
3	-0.40	130	0.60	440	-0.10	190	-0.10	190	-0.60	110	....	...
4	-0.50	120	0.30	320	-0.20	165	-0.10	190	-0.60	110	....	...
5	-0.50	120	0.20	280	-0.30	145	-0.20	165	-0.60	110	1.50	1005
6	-0.60	110	0.20	280	-0.30	145	0.00	220	-0.60	110	3.20	2830
7	-0.60	110	0.10	250	0.80	545	-0.20	165	-0.60	110	2.30	1710
8	-0.60	110	0.10	250	0.80	545	-0.20	165	-0.60	110	1.80	1240
9	-0.60	110	0.20	280	0.60	440	-0.30	145	-0.60	110	1.40	935
10	-0.40	130	0.20	280	0.40	360	-0.30	145	-0.60	110	1.30	860
11	-0.30	145	0.20	280	0.20	280	-0.10	190	-0.60	110	1.20	790
12	-0.40	130	0.10	250	0.30	320	-0.30	145	-0.60	110	3.00	2550
13	-0.50	120	0.10	250	0.30	320	-0.30	145	-0.60	110	2.40	1820
14	-0.60	110	0.00	220	0.10	250	0.10	250	-0.60	110	1.40	935
15	-0.60	110	0.00	220	0.00	220	-0.10	190	-0.30	145	1.00	660
16	-0.60	110	0.00	220	0.00	220	-0.20	165	0.00	220	0.60	440
17	-0.70	100	0.00	220	0.30	320	-0.30	145	0.50	400	0.60	440
18	-0.70	100	0.10	250	0.20	280	-0.30	145	1.40	935	0.80	545
19	-0.70	100	0.40	360	0.20	280	-0.30	145	1.00	660	0.80	545
20	-0.80	90	1.70	1160	0.20	280	-0.30	145	0.80	545	0.80	545
21	-0.40	130	1.30	860	0.10	250	-0.30	145	0.60	440	0.80	545
22	-0.60	110	1.00	660	0.10	250	-0.30	145	0.40	360	0.70	490
23	-0.50	120	1.00	660	0.30	320	-0.40	130	0.30	320	....	...
24	-0.50	120	1.10	720	0.60	440	-0.40	130	0.20	280	....	...
25	-0.30	145	0.90	600	0.50	400	-0.50	120	0.60	440	....	...
26	4.00	4090	0.70	490	0.40	360	-0.60	110	1.00	660	....	...
27	2.80	2285	0.70	490	0.20	280	-0.60	110	2.20	1605	....	...
28	1.80	1240	0.60	440	0.20	280	-0.60	110	1.60	1080	....	...
29	1.40	935	0.60	440	0.20	280	-0.60	110	1.60	1080	....	...
30	1.00	660	0.50	400	0.10	250	-0.60	110	0.90	600	....	...
31	0.00	220	0.30	320	....	...	-0.60	110	....	....	....	...

Note. No record for June.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1888.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	....	....	2.80	2285	5.40	6780	1.70	1160	2.20	1605
2	....	....	....	....	2.80	2285	5.00	5930	1.60	1080	2.00	1415
3	....	....	....	....	3.20	2830	6.00	8215	1.60	1080	1.90	1325
4	....	....	....	....	3.80	3750	5.50	7010	1.50	1005	1.80	1240
5	....	....	....	....	3.20	2830	5.10	6130	1.50	1005	1.70	1160
6	....	....	....	....	3.00	2550	8.00	13800	1.90	1325	1.60	1080
7	....	....	....	....	2.80	2285	10.00	19800	1.80	1240	1.50	1005
8	6.00	8215	....	....	2.70	2160	6.70	10060	1.60	1080	1.40	935
9	5.40	6780	....	....	2.40	1820	5.70	7475	1.60	1080	1.20	790
10	4.60	5165	....	....	2.20	1605	5.10	6130	1.80	1240	1.00	660
11	3.60	3435	....	....	2.00	1415	5.30	6560	2.00	1415	1.00	660
12	2.80	2285	....	....	2.00	1415	5.40	6780	1.80	1240	1.10	720
13	2.30	1710	....	....	1.80	1240	4.70	5350	1.80	1240	1.80	1240
14	2.30	1710	....	....	1.60	1080	4.10	4260	2.00	1415	1.40	935
15	2.50	1930	....	....	....	....	3.50	3280	2.20	1605	1.10	720
16	2.90	2415	....	....	....	....	3.40	3125	1.90	1325	1.20	790
17	2.40	1820	....	....	....	....	3.00	2550	1.60	1080	1.60	1080
18	2.30	1710	....	....	....	....	2.80	2285	1.40	935	1.40	935
19	2.10	1505	....	....	....	....	3.00	2550	1.50	1005	0.90	600
20	2.10	1505	....	....	1.20	790	2.80	2285	1.60	1080	0.80	545
21	2.00	1415	....	....	2.60	2040	3.00	2550	1.60	1080	0.70	490
22	....	....	....	....	5.60	7240	2.90	2415	1.40	935	0.50	400
23	....	....	3.40	3125	5.20	6340	2.70	2160	1.30	860	0.40	360
24	....	....	3.30	2975	4.10	4260	2.60	2040	1.30	860	0.70	490
25	....	....	3.30	2975	3.70	3590	2.50	1930	1.20	790	0.80	545
26	....	....	4.40	4795	3.60	3435	2.50	1930	1.20	790	0.70	490
27	....	....	4.20	4435	3.50	3280	2.30	1710	1.20	790	0.50	400
28	....	....	3.90	3920	3.50	3280	2.10	1505	1.20	790	0.50	400
29	....	....	3.00	2550	4.30	4615	1.90	1325	1.50	1005	0.70	490
30	....	....	....	....	5.40	6780	1.80	1240	3.50	3280	0.80	545
31	....	....	....	....	4.50	4980	....	....	2.80	2285	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.80	545	-0.50	120	0.50	400	-0.50	120	1.60	1080	1.60	1080
2	0.60	440	-0.50	120	0.10	250	....	...	1.40	935	1.50	1005
3	0.40	360	-0.60	110	-0.20	165	....	...	1.30	860	1.30	860
4	0.30	320	-0.60	110	-0.40	130	....	...	2.40	1820	1.20	790
5	0.20	280	-0.40	130	-0.50	120	....	...	2.20	1605	1.20	790
6	0.00	220	-0.50	120	-0.60	110	....	...	2.00	1415	1.10	720
7	0.00	220	-0.20	165	-0.60	110	....	...	2.20	1605	1.00	660
8	-0.10	190	-0.30	145	-0.50	120	2.80	2285	2.40	1820	1.00	660
9	-0.10	190	-0.40	130	-0.50	120	....	...	3.00	2550	1.00	660
10	-0.20	165	-0.40	130	-0.60	110	....	...	3.80	3750	1.20	790
11	-0.30	145	-0.50	120	-0.60	110	....	...	4.80	5540	1.20	790
12	-0.30	145	-0.50	120	-0.60	110	1.80	1240	4.00	4090	1.00	660
13	-0.00	220	-0.10	190	-0.60	110	....	...	3.40	3125	0.90	600
14	-0.10	190	0.20	280	-0.60	110	....	...	2.80	2285	0.90	600
15	-0.10	190	0.80	545	-0.60	110	2.20	1605	2.50	1930	0.80	545
16	-0.20	165	0.80	545	-0.60	110	....	...	2.40	1820	0.80	545
17	-0.20	165	0.50	400	-0.20	165	....	...	2.80	2285	0.90	600
18	-0.30	145	1.20	790	-0.20	165	....	...	3.00	2550	4.20	4435
19	-0.30	145	2.50	1930	-0.30	145	....	...	2.80	2285	3.30	2975
20	-0.10	190	1.80	1240	-0.40	130	....	...	2.80	2285	2.70	2160
21	-0.20	165	1.30	860	-0.50	120	....	...	3.00	2550	2.50	1930
22	-0.20	165	1.30	860	-0.10	190	3.10	2690	3.00	2550	2.10	1505
23	-0.30	145	1.80	1240	-0.20	165	....	...	2.70	2160	2.00	1415
24	-0.30	145	1.00	660	-0.40	130	....	...	2.30	1710	1.80	1240
25	-0.40	130	0.70	490	-0.50	120	....	...	2.10	1505	1.70	1160
26	-0.40	130	0.50	400	-0.50	120	....	...	2.00	1415	1.70	1160
27	-0.40	130	0.50	400	-0.50	120	....	...	1.90	1325	1.80	1240
28	-0.40	130	0.40	360	-0.60	110	....	...	1.70	1160	2.00	1415
29	-0.40	130	0.40	360	-0.60	110	1.80	1240	1.60	1080	3.50	3280
30	-0.40	130	1.20	790	-0.60	110	....	...	1.60	1080	2.90	2415
31	-0.50	120	0.90	600	....	...	....	...	....	....	2.60	2040

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1889.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.30	1710	2.80	2285	....	....	3.10	2690	4.20	4435	17.00	43000	4.00	4090	....	....	....	....	....	....	1.30	860	2.40	1820
2	2.10	1505	2.50	1930	....	....	4.80	5540	3.90	3920	12.00	26100	....	....	....	....	-0.70	110	....	....	1.20	790	2.00	1415
3	2.00	1415	2.30	1710	....	....	5.00	5930	3.60	3435	6.30	8990	....	....	....	....	....	....	....	....	1.20	790	2.00	1415
4	1.80	1240	2.00	1415	....	....	4.50	4980	3.30	2975	....	....	10.00	19800	0.40	360	....	....	....	....	3.00	2550	1.70	1160
5	1.60	1080	1.80	1240	....	....	4.00	4090	3.00	2550	....	....	....	....	....	....	....	....	....	....	2.70	2160	1.70	1160
6	1.60	1080	1.80	1240	....	....	3.70	3590	2.80	2285	....	....	....	....	....	....	....	....	....	....	2.20	1605	1.70	1160
7	2.60	2040	....	....	3.90	3920	4.50	4980	....	....	....	....	....	....	....	....	....	....	0.30	320	1.90	1325	1.60	1080
8	2.40	1820	....	....	2.50	1930	4.60	5165	....	....	....	....	3.50	3280	....	....	....	....	....	....	1.80	1240	1.60	1080
9	2.30	1710	....	....	2.00	1415	4.10	4260	....	....	....	....	....	....	....	....	-0.50	120	....	....	1.40	935	2.00	1415
10	2.50	1930	....	....	2.00	1415	3.90	3920	....	....	4.40	4795	....	....	....	....	....	....	....	....	1.10	720	4.00	4090
11	2.40	1820	....	....	1.80	1240	3.80	3750	2.70	2160	....	....	....	....	....	....	....	....	....	....	1.00	660	4.10	4260
12	2.10	1505	....	....	1.80	1240	3.70	3590	3.30	2975	....	....	....	....	-0.10	190	....	....	....	....	1.00	660	5.50	7010
13	1.90	1325	....	....	1.80	1240	3.80	3750	3.20	2830	....	....	....	....	....	....	....	....	....	....	1.00	660	4.30	4615
14	1.90	1325	....	....	1.90	1325	4.00	4090	3.50	3280	....	....	....	....	....	....	....	....	2.60	2040	1.30	860	4.00	4090
15	1.90	1325	....	....	2.80	2285	3.80	3750	....	....	....	....	2.00	1415	....	....	....	....	....	....	1.00	660	5.80	7715
16	1.90	1325	....	....	3.40	3125	3.70	3590	....	....	....	....	....	....	....	....	-0.80	90	....	....	1.80	1240	5.00	5930
17	1.90	1325	....	....	4.20	4435	3.60	3435	....	....	3.40	3125	....	....	....	....	....	....	....	....	1.50	1005	4.80	5540
18	1.90	1325	....	....	5.00	5930	3.40	3125	....	....	6.20	8730	....	....	....	....	....	....	....	....	1.60	1080	4.40	4795
19	1.70	1160	....	....	5.50	7010	3.00	2550	....	....	....	....	....	....	-0.30	145	....	....	....	....	3.20	2830	4.40	4795
20	1.60	1080	....	....	5.70	7475	2.70	2160	2.90	2415	6.50	9520	....	....	....	....	....	....	....	....	4.40	4795	4.20	4435
21	1.60	1080	....	....	5.50	7010	2.40	1820	....	....	....	....	....	....	....	....	....	....	....	....	4.20	4435	4.00	4090
22	1.40	935	....	....	4.90	5730	2.20	1605	....	....	....	....	0.80	545	....	....	....	....	....	....	4.00	4090	3.70	3590
23	1.40	935	....	....	4.00	4090	2.00	1415	....	....	....	....	....	....	....	....	0.50	400	....	....	4.00	4090	3.50	3280
24	1.30	860	....	....	3.80	3750	1.80	1240	....	....	4.00	4090	....	....	....	....	....	....	....	....	3.30	2975	3.30	2975
25	1.30	860	....	....	3.80	3750	1.90	1325	....	....	....	....	....	....	....	....	....	....	....	....	2.80	2285	3.10	2690
26	1.30	860	....	....	3.70	3590	2.70	2160	....	....	....	....	....	....	0.30	320	....	....	....	....	2.50	1930	3.10	2690
27	1.30	860	....	....	3.60	3435	3.40	3125	1.80	1240	....	....	....	....	....	....	....	....	....	....	2.20	1605	2.80	2285
28	3.60	3435	....	....	3.30	2975	3.70	3590	....	....	....	....	....	....	....	....	....	....	1.70	1160	2.20	1605	2.60	2040
29	4.60	5165	....	....	3.10	2690	3.90	3920	....	....	....	....	0.50	400	....	....	....	....	....	....	2.00	1415	2.40	1820
30	3.80	3750	....	....	2.90	2415	5.00	5930	....	....	....	....	....	....	....	....	-0.30	145	....	....	3.20	2830	2.20	1605
31	3.20	2830	....	....	7.80	2285	....	....	2.20	1605	....	....	....	....	....	....	....	....	....	....	....	....	1.80	1240

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1890.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.60	1080	2.10	1505	5.60	7240	3.70	3590	....	.....	2.20	1605	1.20	790	-0.40	130	2.10	1505	1.30	860	2.60	2040	1.60	1080
2	1.80	1240	2.00	1415	4.60	5165	3.70	3590	3.80	3750	2.00	1415	1.00	660	-0.40	130	2.00	1415	1.00	660	2.50	1930	1.50	1005
3	2.20	1605	2.00	1415	4.00	4090	3.40	3125	....	.....	....	....	0.80	545	-0.50	120	1.90	1325	2.00	1415	2.50	1930	1.50	1005
4	2.40	1820	2.10	1505	2.80	2285	3.60	3435	....	.....	....	....	0.70	490	-0.60	110	1.80	1240	3.00	2550	2.50	1930	1.50	1005
5	2.20	1605	2.60	2040	2.70	2160	5.40	6780	4.20	4435	....	....	1.20	790	-0.40	130	1.70	1160	2.60	2040	2.40	1820	1.40	935
6	4.40	4795	3.40	3125	2.60	2040	4.40	4795	....	.....	....	....	0.80	545	0.40	360	1.80	1240	2.00	1415	2.20	1605	1.40	935
7	6.80	10355	3.00	2550	2.30	1710	3.80	3750	....	.....	....	....	0.50	400	0.10	250	1.40	935	3.00	2550	2.00	1415	1.40	935
8	5.00	5930	3.40	3125	2.00	1415	3.70	3590	....	.....	....	....	0.30	320	1.20	790	1.00	660	3.20	2830	2.00	1415	1.30	860
9	4.00	4090	3.20	2830	1.80	1240	5.30	6560	....	.....	1.80	1240	0.20	280	0.60	440	1.00	660	2.80	2285	2.10	1505	1.20	790
10	3.60	3435	2.90	2415	1.80	1240	5.30	6560	....	.....	....	....	0.00	220	0.80	545	4.00	4090	2.50	1930	2.20	1605	1.20	790
11	3.30	2975	2.60	2040	1.80	1240	4.80	5540	8.00	13800	....	....	-0.10	190	1.40	935	8.60	15600	2.10	1505	4.00	4090	1.10	720
12	3.10	2690	2.50	1930	2.80	2285	4.60	5165	8.80	16200	....	....	-0.30	145	1.30	860	8.00	13800	2.00	1415	4.60	5165	1.10	720
13	5.00	5930	2.30	1710	3.70	3590	4.30	4615	....	.....	....	....	-0.30	145	0.90	600	5.50	7010	1.90	1325	4.00	4090	1.00	660
14	4.60	5165	2.10	1505	4.70	5350	3.90	3920	....	.....	....	....	-0.40	130	0.30	320	6.80	10355	3.00	2550	3.40	3125	....	....
15	4.00	4090	3.60	3435	5.00	5930	3.60	3435	....	.....	....	....	-0.40	130	-0.20	165	5.50	7010	2.80	2285	3.00	2550	....	....
16	6.50	9520	4.60	5165	3.80	3750	3.30	2975	....	.....	1.70	1160	-0.50	120	-0.50	120	5.00	5930	2.50	1930	3.00	2550	....	....
17	7.00	10900	4.00	4090	3.30	2975	3.00	2550	....	.....	....	....	-0.50	120	-0.70	100	5.50	7010	3.30	2975	3.20	2830	....	....
18	5.60	7240	3.80	3750	3.30	2975	2.90	2415	....	.....	....	....	-0.10	190	-0.70	100	5.00	5930	5.00	5930	5.20	6340	....	....
19	5.00	5930	3.60	3435	3.30	2975	2.70	2160	3.00	2550	....	....	-0.30	145	-0.70	100	4.00	4090	4.50	4980	5.00	5930	....	....
20	4.60	5165	4.20	4435	3.20	2830	2.50	1930	5.60	7240	....	....	-0.40	130	-0.20	165	3.40	3125	4.40	4795	4.00	4090	....	....
21	4.40	4795	6.30	8990	3.80	3750	2.40	1820	12.00	26100	....	....	-0.50	120	3.60	3435	3.00	2550	3.60	3435	3.60	3435	....	....
22	4.40	4795	5.30	6560	4.40	4795	2.30	1710	....	.....	....	....	-0.60	110	3.00	2550	3.00	2550	3.00	2550	3.20	2830	....	....
23	3.80	3750	4.50	4980	5.40	6780	2.00	1415	5.00	5930	0.50	400	-0.60	110	4.00	4090	2.60	2040	3.20	2830	2.60	2040	....	....
24	3.40	3125	4.00	4090	5.00	5930	1.60	1080	13.50	31050	....	....	-0.60	110	3.70	3590	2.10	1505	5.00	5930	2.30	1710	....	....
25	3.10	2690	4.10	4260	4.40	4795	1.30	860	....	.....	....	....	-0.70	100	2.00	1415	1.60	1080	6.80	10335	2.00	1415	....	....
26	3.00	2550	6.70	10060	3.80	3750	1.40	935	7.00	10900	....	....	-0.70	100	1.60	1080	1.50	1005	4.80	5540	1.80	1240	....	....
27	2.80	2285	6.10	8470	3.30	2975	3.00	2550	....	.....	....	....	-0.40	130	2.50	1930	2.00	1415	4.00	4090	1.80	1240	....	....
28	2.50	1930	5.20	6340	3.30	2975	6.20	8730	....	.....	....	....	0.20	280	2.60	2040	1.70	1160	3.60	3435	1.80	1240	....	....
29	2.30	1710	....	....	3.30	2975	3.30	2975	....	.....	....	....	0.00	220	2.20	1605	1.50	1005	3.20	2830	1.70	1160	....	....
30	2.30	1710	....	....	3.50	3280	4.30	4615	....	.....	1.60	1080	0.30	320	1.80	1240	1.40	935	3.00	2550	1.70	1160	....	....
31	2.30	1710	....	....	3.20	2830	....	....	....	.....	....	....	-0.30	145	1.80	1240	....	....	2.80	2285	....	....	....	....

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1891.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	5.20	6340	2.50	1930	6.00	8215	2.00	1415	-0.10	190	0.40	360	3.50	3280	1.50	1005	....	....	0.80	545	3.50	3280
2	....	....	6.50	9520	2.00	1415	5.80	7715	1.60	1080	-0.10	190	4.20	4435	....	....	....	....	....	....	0.90	600	3.40	3125
3	....	....	6.00	8215	1.70	1160	6.20	8730	1.50	1005	0.00	220	3.00	2550	2.60	2040	....	....	....	....	0.70	490	3.30	2975
4	3.40	3125	5.00	5930	1.70	1160	6.30	8990	1.40	935	3.70	3590	2.80	2285	2.30	1710	....	....	....	....	0.60	440	3.00	2550
5	2.60	2040	4.00	4090	1.60	1080	5.60	7240	1.40	935	2.40	1820	2.40	1820	3.90	3920	....	....	-0.30	145	0.60	440	8.40	15000
6	2.20	1605	3.40	3125	1.40	935	5.20	6340	1.30	860	2.00	1415	1.90	1325	3.00	2550	....	....	....	....	0.50	400	6.00	8215
7	1.90	1325	3.10	2690	1.30	860	4.60	5165	1.20	790	2.20	1605	2.10	1505	....	....	1.80	1240	....	....	0.60	440	5.00	5930
8	1.60	1080	3.80	3750	1.30	860	4.00	4090	1.20	790	2.50	1930	1.50	1005	....	....	....	....	....	....	0.50	400	4.50	4980
9	1.30	860	3.90	3920	1.50	1005	3.80	3750	1.10	720	2.30	1710	0.90	600	....	....	....	....	....	....	0.70	490	4.00	4090
10	....	....	3.80	3750	2.80	2285	3.70	3590	0.90	600	2.00	1415	0.40	360	1.30	860	....	....	....	....	0.10	250	3.40	3125
11	1.30	860	3.80	3750	2.60	2040	3.70	3590	0.80	545	1.70	1160	0.20	280	....	....	....	....	....	....	0.30	320	3.00	2550
12	1.70	1160	3.70	3590	2.90	2415	4.60	5165	0.70	490	2.50	1930	0.00	220	....	....	....	....	0.40	360	3.30	2975	2.80	2285
13	2.30	1710	3.70	3590	3.70	3590	5.20	6340	0.70	490	2.00	1415	0.10	190	....	....	....	....	....	....	2.80	2285	2.60	2040
14	2.00	1415	3.70	3590	3.20	2830	4.60	5165	0.60	440	1.70	1160	-0.30	145	....	....	1.10	720	....	....	2.10	1505	2.20	1605
15	1.80	1240	3.50	3280	3.00	2550	4.90	5730	0.50	400	1.60	1080	-0.50	120	....	....	....	....	....	....	1.80	1240	2.00	1415
16	1.60	1080	4.00	4090	2.70	2160	4.80	5540	0.40	360	1.50	1005	1.00	660	....	....	....	....	....	....	1.70	1160	4.00	4090
17	1.40	935	11.70	25140	2.60	2040	4.80	5540	0.30	320	2.00	1415	0.00	220	1.40	935	....	....	....	....	1.60	1080	7.30	11770
18	1.40	935	13.00	29400	2.40	1820	4.70	5350	0.20	280	2.40	1820	-0.40	130	....	....	....	....	....	....	2.40	1820	5.20	6340
19	1.30	860	8.00	13800	2.20	1605	4.70	5350	0.10	250	2.50	1930	6.20	8730	....	....	....	....	-0.30	145	2.60	2040	3.70	3590
20	1.20	790	6.60	9790	2.00	1415	4.30	4615	0.00	220	3.00	2550	3.50	3280	....	....	....	....	....	....	2.00	1415	3.70	3590
21	1.20	790	6.30	8990	2.20	1605	3.60	3435	0.00	220	3.30	2975	1.50	1005	....	....	0.40	360	....	....	1.90	1325	3.60	3435
22	1.40	935	5.00	5930	2.20	1605	3.20	2830	0.20	280	4.40	4795	0.80	545	....	....	....	....	....	....	2.40	1820	3.00	2550
23	1.90	1325	4.20	4435	2.00	1415	3.00	2550	0.20	280	4.60	5165	3.20	2830	3.60	3435	....	....	....	....	3.30	2975	3.00	2550
24	1.90	1325	3.90	3920	2.00	1415	2.70	2160	0.30	320	3.80	3750	8.50	15300	6.20	8730	....	....	....	....	5.80	7715	5.00	5930
25	1.80	1240	3.70	3590	3.20	2830	2.40	1820	0.30	320	2.40	1820	7.00	10900	....	....	....	....	....	....	5.10	6130	4.40	4795
26	1.70	1160	3.60	3435	3.40	3125	2.30	1710	0.20	280	2.00	1415	3.00	2550	....	....	....	....	0.80	545	4.20	4435	4.60	5165
27	1.70	1160	3.20	2830	3.10	2690	2.20	1605	0.10	250	1.60	1080	1.80	1240	....	....	....	....	....	....	3.70	3590	5.30	6560
28	1.70	1160	3.00	2550	3.00	2550	2.10	1505	0.00	220	1.20	790	1.10	720	....	....	-0.10	190	....	....	4.50	4980	4.50	4980
29	1.70	1160	....	....	3.10	2690	2.10	1505	-0.10	190	0.80	545	1.30	860	....	....	....	....	....	....	6.00	8215	3.60	3435
30	2.20	1605	....	....	3.60	3435	2.00	1415	-0.10	190	0.60	440	3.70	3590	....	....	....	....	....	....	4.80	5540	3.80	3750
31	6.00	8215	....	....	5.00	5930	....	....	-0.10	190	....	...	4.50	4980	1.90	1325	....	....	....	....	....	....	3.40	3125

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1892.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.00	2550	3.70	3590	3.40	3125	4.30	4615	1.30	860	....	....
2	3.00	2550	3.80	3750	2.90	2415	4.20	4435	3.30	2975	....	....
3	3.00	2550	4.00	4090	2.70	2160	6.00	8215	7.00	10900	....	....
4	2.80	2285	4.10	4260	3.00	2550	6.50	9520	7.30	11770	5.80	7715
5	2.60	2040	4.40	4795	2.80	2285	7.40	12060	8.40	15000	....	....
6	2.40	1820	3.70	3590	2.60	2040	6.90	10615	6.20	8730	5.00	5930
7	2.30	1710	3.80	3750	2.30	1710	5.70	7475	6.60	9790	....	....
8	2.00	1415	4.00	4090	2.20	1605	4.50	4980	5.40	6780	....	....
9	1.80	1240	3.80	3750	3.70	3590	4.30	4615	4.40	4795	5.20	6340
10	....	....	3.50	3280	4.00	4090	4.00	4090	4.20	4435	....	....
11	....	....	2.80	2285	3.50	3280	3.50	3280	3.60	3435	....	....
12	....	....	3.00	2550	3.00	2550	3.20	2830	3.60	3435	....	....
13	3.50	3280	2.90	2415	2.70	2160	2.90	2415	3.40	3125	3.30	2975
14	4.30	4615	2.20	1605	2.40	1820	2.70	2160	3.20	2830	....	....
15	6.60	9790	5.00	5930	2.50	1930	2.60	2040	2.90	2415	....	....
16	4.30	4615	6.00	8215	2.30	1710	2.60	2040	4.40	4795	....	....
17	3.20	2830	4.00	4090	2.20	1605	2.50	1930	....	....	....	....
18	3.50	3280	3.10	2690	2.00	1415	2.40	1820	....	....	....	....
19	3.50	3280	2.90	2415	2.00	1415	2.10	1505	....	....	....	....
20	3.00	2550	4.50	4980	1.70	1160	1.80	1240	....	....	3.00	2550
21	2.60	2040	6.00	8215	1.60	1080	1.70	1160	....	....	....	....
22	2.00	1415	5.00	5930	1.70	1160	2.00	1415	....	....	....	....
23	2.10	1505	4.50	4980	1.90	1325	2.30	1710	4.80	5540	....	....
24	2.20	1605	4.30	4615	2.80	2285	2.30	1710	....	....	....	....
25	2.30	1710	4.30	4615	3.20	2830	2.20	1605	....	....	....	....
26	2.80	2285	4.20	4435	3.90	3920	2.00	1415	....	....	....	....
27	3.00	2550	4.00	4090	5.90	7965	1.70	1160	....	....	2.80	2285
28	3.10	2690	3.80	3750	8.10	14100	1.60	1080	....	....	....	....
29	3.30	2975	3.50	3280	6.00	8215	1.60	1080	....	....	....	....
30	4.10	4260	....	....	5.20	6340	1.40	935	4.20	4435	....	....
31	3.50	3280	....	....	4.70	5350	....	...	....	....	....	....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	0.80	545	0.10	250	0.10	250	-0.20	165	0.70	490
2	....	....	0.40	360	0.10	250	0.00	220	-0.10	190	0.70	490
3	....	....	0.80	545	0.00	220	-0.20	165	-0.20	165	1.00	660
4	2.10	1505	0.60	440	-0.10	190	-0.20	165	-0.30	145	0.20	280
5	....	....	0.50	400	-0.50	120	-0.20	165	0.70	490	0.50	400
6	....	....	0.00	220	-0.50	120	-0.10	190	0.70	490	0.50	400
7	....	....	0.10	250	-0.30	145	-0.20	165	0.50	400	0.90	600
8	....	....	0.30	320	-0.20	165	-0.30	145	0.10	250	1.20	790
9	....	....	0.20	280	-0.20	165	-0.10	190	-0.10	190	2.80	2285
10	....	....	0.00	220	-0.30	145	-0.30	145	1.00	660	3.80	3750
11	0.60	440	-0.10	190	-0.20	165	-0.40	130	0.60	440	2.30	1710
12	....	....	0.20	280	0.50	400	-0.40	130	0.20	280	1.80	1240
13	0.40	360	1.80	1240	0.00	220	-0.50	120	0.50	400	1.50	1005
14	0.60	440	1.10	720	0.10	250	-0.50	120	0.20	280	2.00	1415
15	0.60	440	0.90	600	0.20	280	-0.50	120	0.60	440	1.50	1005
16	0.70	490	0.80	545	0.20	280	-0.50	120	0.60	440	1.70	1160
17	0.60	440	0.50	400	0.80	545	-0.60	110	0.80	545	1.40	935
18	0.50	400	0.20	280	0.20	280	-0.60	110	0.80	545	1.40	935
19	0.50	400	0.10	250	-0.20	165	-0.60	110	1.30	860	1.30	860
20	0.40	360	-0.40	130	0.10	250	-0.60	110	2.50	1930	1.30	860
21	0.20	280	-0.50	120	0.10	250	-0.00	220	0.80	545	1.10	720
22	0.10	250	-0.50	120	-0.10	190	-0.40	130	1.30	860	0.90	600
23	0.00	220	-0.50	120	-0.10	190	-0.30	145	1.00	660	0.70	490
24	-0.10	190	-0.60	110	-0.30	145	-0.40	130	0.60	440	0.50	400
25	0.40	360	-0.50	120	-0.40	130	-0.60	110	0.50	400	0.90	600
26	0.20	280	-0.50	120	-0.30	145	-0.60	110	0.50	400	1.00	660
27	0.10	250	-0.40	130	-0.10	190	-0.60	110	0.50	400	1.50	1005
28	0.20	280	-0.40	130	1.00	660	0.10	250	1.00	660	1.30	860
29	-0.20	165	0.50	400	0.70	490	-0.40	130	0.70	490	1.60	1080
30	0.50	400	0.30	320	0.20	280	-0.40	130	1.30	860	....	....
31	1.00	660	0.30	320	....	...	-0.40	130	....	...	....	....

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1893.

Day	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	...	7.00	10900	3.50	3280	3.30	2975	2.00	1415	0.80	545	–0.40	130	1.50	1005	–0.30	145	0.20	280	3.10	2690
2	....	...	6.90	10615	4.60	5165	4.60	5165	1.70	1160	0.70	490	–0.50	120	0.50	400	–0.30	145	0.20	280	2.20	1605
3	....	...	6.70	10060	4.80	5540	4.50	4980	2.00	1415	0.70	490	–0.60	110	0.40	360	–0.40	130	0.30	320	2.10	1505
4	6.00	8215	3.20	2830	4.80	5540	4.20	4435	1.60	1080	0.60	440	–0.60	110	0.30	320	–0.30	145	0.10	250	2.30	1710
5	6.50	9520	4.00	4090	6.20	8730	4.00	4090	1.40	935	0.60	440	–0.60	110	0.30	320	0.20	280	0.20	280	3.20	2830
6	6.00	8215	4.00	4090	5.20	6340	3.80	3750	1.60	1080	0.60	440	–0.50	120	0.20	280	0.10	250	0.60	440	2.20	1605
7	10.00	19800	3.90	3920	4.80	5540	3.60	3435	1.20	790	0.40	360	–0.40	130	0.20	280	0.00	220	0.40	360	2.20	1605
8	9.90	19500	4.20	4435	6.20	8730	3.50	3280	1.20	790	0.40	360	–0.20	165	0.40	360	0.00	220	0.40	360	2.00	1415
9	7.00	10900	6.60	9790	5.80	7715	3.10	2690	1.10	720	0.60	440	–0.20	165	0.20	280	0.60	440	0.30	320	2.00	1415
10	7.30	11770	5.80	7715	5.90	7965	2.70	2160	0.90	600	0.60	440	–0.30	145	0.00	220	0.30	320	0.30	320	1.90	1325
11	9.50	18300	6.30	8990	5.00	5930	2.50	1930	0.80	545	0.50	400	–0.40	130	0.10	250	0.20	280	0.20	280	1.80	1240
12	6.70	10060	6.90	10615	5.00	5930	2.30	1710	0.50	400	0.50	400	–0.50	120	–0.10	190	0.20	280	0.10	250	1.60	1080
13	5.00	5930	6.90	10615	4.50	4980	2.10	1505	0.50	400	0.40	360	–0.50	120	–0.20	165	0.10	250	0.40	360	1.40	935
14	4.60	5165	5.80	7715	4.30	4615	3.50	3280	0.40	360	0.40	360	–0.70	100	–0.40	130	0.30	320	0.30	320	1.80	1240
15	4.50	4980	5.70	7475	4.30	4615	5.50	7010	0.30	320	0.50	400	–0.70	100	–0.50	120	0.30	320	0.20	280	1.80	1240
16	6.70	10060	5.20	6340	5.30	6560	5.00	5930	0.20	280	0.80	545	–0.80	90	–0.60	110	2.10	1505	0.10	250	6.40	9255
17	5.50	7010	4.10	4260	4.40	4795	6.80	10355	0.30	320	0.40	360	–0.70	100	–0.50	120	1.40	935	0.10	250	8.10	14100
18	4.60	5165	3.80	3750	4.00	4090	6.70	10060	0.10	250	2.10	1505	–0.70	100	–0.50	120	1.00	660	0.20	280	5.50	7010
19	4.00	4090	3.50	3280	3.90	3920	5.40	6780	0.10	250	1.50	1005	–0.80	90	–0.60	110	0.80	545	0.20	280	4.30	4615
20	3.50	3280	3.30	2975	3.60	3435	4.50	4980	0.00	220	1.20	790	–0.80	90	–0.60	110	0.60	440	0.10	250	4.00	4090
21	2.80	2285	3.30	2975	7.30	11770	4.20	4435	0.00	220	0.90	600	–0.80	90	–0.60	110	0.40	360	0.10	250	3.10	2690
22	2.50	1930	4.30	4615	6.90	10615	4.00	4090	2.00	1415	0.60	440	–0.70	100	–0.70	100	0.30	320	0.30	320	2.90	2415
23	2.10	1505	6.10	8470	5.60	7240	3.80	3750	1.30	860	0.30	320	–0.70	100	–0.70	100	0.30	320	0.80	545	3.00	2550
24	2.00	1415	7.10	11190	4.80	5540	3.20	2830	1.00	660	0.10	250	–0.80	90	–0.70	100	0.40	360	1.40	935	3.30	2975
25	1.70	1160	7.00	10900	4.20	4435	3.50	3280	0.80	545	0.10	250	–0.80	90	–0.60	110	0.10	250	1.40	935	4.30	4615
26	1.70	1160	6.10	8470	4.00	4090	3.20	2830	0.80	545	–0.30	145	–0.70	100	–0.30	145	0.30	320	1.00	660	4.00	4090
27	6.50	9520	5.10	6130	3.60	3435	3.20	2830	0.50	400	–0.40	130	–0.70	100	–0.30	145	0.00	220	1.00	660	4.70	5350
28	6.60	9790	4.40	4795	3.60	3435	2.60	2040	1.70	1160	0.10	250	–0.90	80	0.20	280	0.00	220	1.00	660	3.60	3435
29	....	....	4.00	4090	2.30	1710	2.80	2285	2.10	1505	0.20	280	1.00	660	0.00	220	0.00	220	4.00	4090	3.40	3125
30	....	....	4.00	4090	2.90	2415	2.50	1930	1.50	1005	0.00	220	3.30	2975	–0.10	190	0.20	280	2.90	2415	4.50	4980
31	....	....	3.80	3750	....	....	2.10	1505	....	...	–0.20	165	2.00	1415	....	...	0.30	320	....	....	4.00	4090

Frozen January 1 to February 3, inclusive.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1894.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.10	2690	1.90	1325	2.00	1415	2.40	1820	2.40	1820	3.80	3750	0.60	440	-0.10	190	-1.30	40	0.80	545	0.80	545	1.30	860
2	3.00	2550	2.60	2040	2.20	1605	2.20	1605	2.10	1505	3.40	3125	0.60	440	-0.10	190	-1.30	40	0.70	490	2.00	1415	1.80	1240
3	2.80	2285	2.70	2160	2.70	2160	2.20	1605	1.90	1325	4.00	4090	0.50	400	-0.10	190	-1.30	40	0.70	490	1.60	1080	2.80	2285
4	2.80	2285	2.20	1605	2.70	2160	2.10	1505	1.70	1160	5.40	6780	0.50	400	0.20	280	-1.40	30	0.60	440	1.70	1160	3.00	2550
5	2.90	2415	2.50	1930	3.00	2550	2.10	1505	1.60	1080	4.50	4980	0.40	360	0.10	250	-1.40	30	0.50	400	2.20	1605	2.50	1930
6	6.10	8470	2.20	1605	4.00	4090	2.00	1415	1.60	1080	4.00	4090	0.40	360	0.00	220	-1.00	70	0.40	360	2.30	1710	2.10	1505
7	4.50	4980	2.20	1605	5.70	7475	2.00	1415	2.20	1605	3.50	3280	0.30	320	-0.10	190	-1.30	40	0.40	360	2.50	1930	1.90	1325
8	3.90	3920	2.50	1930	6.20	8730	2.10	1505	2.20	1605	3.20	2830	0.10	250	-0.20	165	-0.50	120	0.50	400	2.30	1710	1.80	1240
9	3.40	3125	2.80	2285	5.00	5930	2.20	1605	2.10	1505	2.90	2415	0.10	250	-0.30	145	0.80	545	0.60	440	2.30	1710	2.00	1415
10	3.20	2830	3.80	3750	4.50	4980	2.60	2040	1.90	1325	2.70	2160	0.00	220	-0.40	130	1.20	790	0.50	400	2.10	1505	2.10	1505
11	2.90	2415	4.30	4615	3.90	3920	2.90	2415	1.80	1240	2.80	2285	0.00	220	-0.50	120	1.70	1160	0.40	360	1.80	1240	2.20	1605
12	2.70	2160	3.80	3750	3.80	3750	2.80	2285	1.80	1240	2.60	2040	-0.10	190	-0.60	110	1.30	860	0.30	320	2.30	1710	2.40	1820
13	1.90	1325	3.00	2550	3.50	3280	3.10	2690	1.70	1160	2.40	1820	-0.10	190	-0.70	100	1.10	720	0.20	280	1.90	1325	3.60	3435
14	1.70	1160	2.80	2285	3.20	2830	3.50	3280	1.40	935	2.40	1820	-0.10	190	-0.70	100	1.20	790	0.10	250	1.60	1080	3.70	3590
15	2.00	1415	3.00	2550	3.00	2550	3.80	3750	1.20	790	2.00	1415	-0.10	190	-0.80	90	1.50	1005	0.10	250	1.40	935	3.30	2975
16	2.00	1415	3.00	2550	2.50	1930	3.50	3280	1.00	660	1.80	1240	0.00	220	-0.80	90	1.90	1325	0.20	280	1.60	1080	3.00	2550
17	1.80	1240	2.80	2285	2.80	2285	3.30	2975	2.00	1415	1.60	1080	-0.10	190	-0.80	90	2.50	1930	0.60	440	2.00	1415	2.80	2285
18	1.80	1240	2.80	2285	2.90	2415	3.20	2830	6.40	9255	1.60	1080	-0.10	190	-0.90	80	2.20	1605	0.50	400	2.70	2160	2.50	1930
19	1.60	1080	3.50	3280	2.90	2415	3.10	2690	4.10	4260	1.40	935	-0.20	165	-0.90	80	2.00	1415	0.40	360	2.60	2040	2.40	1820
20	2.10	1505	3.90	3920	2.80	2285	3.70	3590	11.20	23540	1.40	935	-0.40	130	-0.90	80	6.30	8990	0.40	360	2.20	1605	2.20	1605
21	2.00	1415	3.50	3280	2.80	2285	6.30	8990	15.20	36780	1.30	860	-0.50	120	-1.00	70	4.80	5540	0.40	360	2.00	1415	2.00	1415
22	2.40	1820	2.80	2285	2.60	2040	5.40	6780	9.00	16800	1.10	720	-0.50	120	-1.00	70	3.30	2975	0.50	400	1.80	1240	1.90	1325
23	2.50	1930	2.60	2040	3.60	3435	4.60	5165	6.40	9255	1.00	660	-0.60	110	-1.10	60	2.60	2040	0.40	360	1.80	1240	1.90	1325
24	2.20	1605	2.40	1820	4.50	4980	4.30	4615	5.00	5930	0.90	600	-0.60	110	-1.10	60	2.40	1820	0.40	360	1.70	1160	1.80	1240
25	3.50	3280	2.40	1820	3.80	3750	4.10	4260	4.30	4615	0.80	545	-0.60	110	-1.10	60	2.20	1605	0.60	440	1.80	1240	1.60	1080
26	4.20	4435	2.20	1605	3.50	3280	3.70	3590	3.90	3920	0.70	490	-0.70	100	-1.10	60	2.00	1415	1.40	935	2.40	1820	1.60	1080
27	3.50	3280	2.10	1505	3.00	2550	3.40	3125	3.40	3125	0.80	545	-0.60	110	-1.10	60	1.70	1160	1.30	860	1.80	1240	1.80	1240
28	2.80	2285	2.00	1415	2.60	2040	2.90	2415	3.10	2690	1.50	1005	-0.30	145	-1.20	50	1.50	1005	1.10	720	1.70	1160	1.50	1005
29	2.50	1930	....	....	2.50	1930	2.50	1930	2.90	2415	0.80	545	-0.40	130	-1.20	50	1.30	860	0.80	545	1.50	1005	1.20	790
30	2.40	1820	....	....	2.50	1930	2.50	1930	3.00	2550	0.70	490	-0.40	130	-1.20	50	1.10	720	0.70	490	1.30	860	1.10	720
31	2.00	1415	....	....	2.40	1820	....	....	2.90	2415	....	...	0.00	220	-1.20	50	....	...	0.70	490	....	....	1.00	660

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1895.

Day	January Gage Ht.	January Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.90	600	....	....	3.60	3435	1.50	1005	0.70	490	1.90	1325	1.20	790	0.00	220	–0.10	190	–0.90	80
2	1.30	860	....	....	4.50	4980	1.40	935	0.70	490	1.70	1160	1.00	660	–0.20	165	–0.20	165	–0.80	90
3	1.30	860	5.00	5930	4.30	4615	1.30	860	0.60	440	1.70	1160	1.00	660	–0.20	165	–0.20	165	–0.80	90
4	a	...	3.50	3280	3.70	3590	1.30	860	0.50	400	1.60	1080	0.90	600	–0.30	145	–0.30	145	1.00	660
5	a	...	3.50	3280	3.00	2550	1.30	860	0.50	400	1.30	860	0.70	490	–0.40	130	–0.40	130	0.70	490
6	a	...	3.40	3125	3.50	3280	1.20	790	0.50	400	1.80	1240	0.60	440	–0.50	120	–0.50	120	0.50	400
7	a	...	2.80	2285	4.10	4260	1.20	790	0.60	440	2.40	1820	0.80	545	–0.60	110	–0.60	110	0.40	360
8	7.00	10900	2.60	2040	5.00	5930	1.10	720	0.60	440	1.80	1240	2.90	2415	–0.70	100	–0.60	110	0.20	280
9	5.70	7475	2.60	2040	9.80	19200	1.10	720	0.50	400	1.80	1240	2.10	1505	–0.80	90	–0.60	110	0.10	250
10	3.80	3750	2.50	1930	10.50	21350	1.70	1160	0.50	400	2.20	1605	1.20	790	–0.90	80	–0.60	110	0.00	220
11	3.80	3750	2.50	1930	6.70	10060	1.40	935	0.40	360	1.90	1325	1.00	660	–0.90	80	–0.60	110	0.00	220
12	4.80	5540	2.90	2415	5.20	6340	1.40	935	0.30	320	1.70	1160	0.90	600	–0.90	80	–0.60	110	0.50	400
13	3.70	3590	3.00	2550	5.80	7715	1.30	860	0.40	360	1.50	1005	1.20	790	–0.30	145	–0.70	100	0.30	320
14	3.00	2550	3.50	3280	6.80	10355	1.30	860	0.30	320	1.30	860	1.20	790	–0.10	190	–0.70	100	0.10	250
15	2.60	2040	3.30	2975	5.80	7715	1.20	790	0.50	400	1.10	720	1.10	720	–0.10	190	–0.70	100	0.10	250
16	2.40	1820	3.10	2690	4.60	5165	1.10	720	0.50	400	1.00	660	0.90	600	–0.10	190	–0.70	100	0.30	320
17	2.20	1605	2.90	2415	3.90	3920	1.20	790	0.40	360	0.90	600	0.90	600	–0.10	190	–0.70	100	0.30	320
18	2.60	2040	2.90	2415	3.60	3435	1.10	720	0.30	320	0.80	545	0.50	400	–0.10	190	–0.80	90	0.20	280
19	2.60	2040	2.80	2285	2.80	2285	1.10	720	0.20	280	0.80	545	0.30	320	0.50	400	–0.80	90	0.00	220
20	2.70	2160	2.50	1930	2.70	2160	1.50	1005	0.10	250	0.80	545	0.30	320	1.80	1240	–0.80	90	–0.10	190
21	3.00	2550	2.40	1820	2.50	1930	1.50	1005	0.20	280	0.80	545	0.30	320	1.80	1240	–0.80	90	....	...
22	2.50	1930	2.20	1605	2.00	1415	1.40	935	2.30	1710	1.60	1080	0.30	320	1.60	1080	–0.80	90	....	...
23	2.20	1605	2.20	1605	1.90	1325	1.10	720	2.50	1930	1.60	1080	0.20	280	1.40	935	–0.80	90	....	...
24	2.00	1415	3.00	2550	1.80	1240	0.90	600	2.20	1605	1.40	935	0.10	250	0.90	600	–0.80	90	....	...
25	1.80	1240	4.20	4435	1.80	1240	0.90	600	2.00	1415	1.20	790	0.10	250	0.70	490	–0.80	90	....	...
26	1.80	1240	6.00	8215	1.70	1160	0.90	600	2.10	1505	1.00	660	0.10	250	0.50	400	–0.90	80	....	...
27	1.70	1160	4.90	5730	1.70	1160	0.80	545	2.10	1505	0.90	600	0.10	250	0.30	320	–0.90	80	....	...
28	1.60	1080	4.00	4090	1.60	1080	0.80	545	3.60	3435	1.80	1240	0.10	250	0.20	280	–0.90	80	....	...
29	1.60	1080	3.70	3590	1.50	1005	0.80	545	2.30	1710	2.30	1710	0.10	250	0.20	280	–0.90	80	....	...
30	1.50	1005	3.60	3435	1.50	1005	0.70	490	2.00	1415	1.60	1080	0.30	320	0.00	220	–0.90	80	....	...
31	1.50	1005	3.30	2975	....	....	0.70	490	....	....	1.40	935	0.30	320	....	...	–0.90	80	....	...

a. Frozen. Note. No record for February and December.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1902.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.40	1820	4.00	4090	14.00	32700	3.30	2975	1.50	1005	1.10	720
2	1.80	1240	3.90	3920	10.60	21660	3.20	2830	1.60	1080	0.80	545
3	1.80	1240	3.60	3435	8.00	13800	2.90	2415	2.40	1820	0.90	600
4	1.70	1160	3.40	3125	6.00	8215	2.80	2285	2.90	2415	0.80	545
5	1.60	1080	3.40	3125	4.90	5730	2.70	2160	2.60	2040	1.20	790
6	1.60	1080	3.30	2975	4.10	4260	3.20	2830	3.50	3280	1.40	935
7	1.60	1080	3.30	2975	3.80	3750	3.30	2975	2.80	2285	1.10	720
8	1.50	1005	3.20	2830	3.30	2975	4.10	4260	3.10	2690	1.50	1005
9	1.50	1005	3.10	2690	3.50	3280	8.30	14700	2.80	2285	0.90	600
10	1.50	1005	3.00	2550	3.80	3750	6.70	10060	2.50	1930	0.90	600
11	1.60	1080	3.00	2550	3.90	3920	5.50	7010	2.30	1710	1.00	660
12	1.80	1240	3.00	2550	4.10	4260	4.70	5350	2.10	1505	0.90	600
13	1.90	1325	2.90	2415	5.40	6780	4.10	4260	2.00	1415	1.10	720
14	2.00	1415	2.80	2285	6.00	8215	3.70	3590	1.90	1325	1.40	935
15	2.00	1415	2.80	2285	5.00	5930	3.20	2830	2.10	1505	1.70	1160
16	1.90	1325	2.70	2160	4.50	4980	3.00	2550	1.60	1080	1.10	720
17	2.00	1415	2.70	2160	5.70	7475	3.00	2550	1.30	860	2.60	2040
18	3.20	2830	2.70	2160	5.40	6780	2.60	2040	1.90	1325	1.60	1080
19	3.20	2830	2.60	2040	4.10	4260	2.40	1820	1.10	720	1.40	935
20	2.90	2415	2.60	2040	3.90	3920	2.60	2040	1.30	860	2.00	1415
21	2.90	2415	2.60	2040	3.40	3125	2.20	1605	1.40	935	1.80	1240
22	3.00	2550	2.50	1930	3.10	2690	2.10	1505	1.80	1240	1.70	1160
23	3.10	2690	2.50	1930	2.90	2415	2.00	1415	2.20	1605	1.60	1080
24	3.20	2830	2.50	1930	2.70	2160	1.90	1325	1.30	860	1.30	860
25	4.00	4090	2.20	1605	2.50	1930	1.60	1080	1.30	860	1.20	790
26	3.70	3590	2.60	2040	2.40	1820	1.50	1005	1.30	860	1.30	860
27	3.80	3750	3.20	2830	2.20	1605	1.40	935	2.10	1505	2.60	2040
28	4.60	5165	7.00	10900	1.80	1240	1.40	935	1.60	1080	1.90	1325
29	4.90	5730	....	....	2.40	1820	1.90	1325	1.40	935	1.60	1080
30	4.70	5350	....	....	3.50	3280	1.40	935	1.20	790	7.80	13220
31	4.60	5165	....	....	3.30	2975	....	...	1.00	660	....	....

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.60	7240	3.60	3435	0.40	360	0.40	360	0.50	400	1.40	935
2	4.60	5165	2.90	2415	0.30	320	2.10	1505	0.60	440	0.40	360
3	4.00	4090	2.70	2160	0.10	250	1.60	1080	0.20	280	1.40	935
4	9.80	19200	2.50	1930	0.30	320	1.30	860	0.20	280	1.80	1240
5	6.20	8730	2.30	1710	0.00	220	0.90	600	0.20	280	2.20	1605
6	5.00	5930	2.00	1415	0.00	220	1.00	660	0.40	360	2.00	1415
7	4.20	4435	1.90	1325	0.10	250	1.20	790	0.30	320	1.60	1080
8	3.70	3590	1.70	1160	0.10	250	1.30	860	0.30	320	1.80	1240
9	3.60	3435	1.80	1240	0.10	250	1.10	720	0.20	280	2.00	1415
10	6.00	8215	1.90	1325	0.60	440	1.00	660	0.30	320	2.60	2040
11	6.90	10615	1.70	1160	0.30	320	0.90	600	0.20	280	2.80	2285
12	4.90	5730	2.00	1415	0.40	360	0.80	545	0.10	250	2.80	2285
13	4.00	4090	1.40	935	0.40	360	1.20	790	0.10	250	3.60	3435
14	3.30	2975	1.30	860	0.00	220	1.60	1080	0.20	280	2.60	2040
15	2.80	2285	1.10	720	0.00	220	1.80	1240	0.10	250	2.50	1930
16	2.60	2040	0.80	545	-0.10	190	2.00	1415	0.10	250	2.50	1930
17	2.30	1710	0.80	545	-0.20	165	1.40	935	0.10	250	4.70	5350
18	2.90	2415	0.50	400	-0.10	190	1.30	860	0.30	320	4.30	4615
19	2.70	2160	0.70	490	-0.10	190	1.00	660	0.90	600	3.50	3280
20	3.00	2550	0.60	440	-0.20	165	1.10	720	0.80	545	3.10	2690
21	4.50	4980	0.50	400	-0.20	165	0.90	600	0.90	600	3.10	2690
22	4.60	5165	0.50	400	-0.10	190	0.80	545	0.80	545	6.40	9255
23	5.40	6780	0.40	360	-0.10	190	0.60	440	0.70	490	5.90	7965
24	4.10	4260	0.40	360	-0.10	190	0.60	440	0.60	440	4.70	5350
25	4.30	4615	0.40	360	0.20	280	0.60	440	0.60	440	4.00	4090
26	5.40	6780	0.30	320	1.00	660	0.40	360	0.70	490	3.40	3125
27	4.00	4090	0.30	320	1.60	1080	0.60	440	1.20	790	2.90	2415
28	3.70	3590	0.10	250	0.80	545	0.40	360	2.00	1415	2.80	2285
29	3.30	2975	0.20	280	0.60	440	0.50	400	1.90	1325	2.40	1820
30	3.40	3125	0.20	280	0.40	360	0.60	440	1.60	1080	2.00	1415
31	4.30	4615	0.70	490	....	...	0.60	440	....	....	3.30	2975

Note. Daily gage heights and discharges for November and December, 1901, will be found on page 164.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1903.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.00	2550	5.70	7475	11.30	23860	3.80	3750	1.40	935	0.60	440	2.00	1415	2.10	1505	2.40	1820	1.00	660	0.70	490	1.80	1240
2	2.00	1415	4.70	5350	7.00	10900	3.00	2550	1.30	860	0.60	440	1.80	1240	1.60	1080	3.20	2830	0.20	280	0.50	400	3.00	2550
3	3.90	3920	7.50	12350	5.50	7010	2.90	2415	1.40	935	0.50	400	1.50	1005	1.30	860	2.40	1820	0.50	400	1.00	660	1.00	660
4	3.80	3750	8.50	15300	4.50	4980	3.30	2975	1.00	660	0.40	360	1.30	860	1.20	790	2.00	1415	0.80	545	0.70	490	2.00	1415
5	3.80	3750	11.00	22900	4.00	4090	3.80	3750	1.90	1325	0.20	280	1.20	790	2.00	1415	1.80	1240	1.00	660	0.70	490	1.90	1325
6	3.30	2975	7.30	11770	5.00	5930	3.10	2690	1.40	935	0.20	280	1.10	720	2.30	1710	1.50	1005	1.90	1325	1.30	860	1.90	1325
7	2.80	2285	5.50	7010	4.80	5540	3.00	2550	1.20	790	0.30	320	2.80	2285	1.70	1160	1.30	860	1.90	1325	0.90	600	1.60	1080
8	2.40	1820	4.50	4980	5.40	6780	3.00	2550	1.00	660	0.20	280	2.10	1505	1.50	1005	1.50	1005	1.80	1240	0.90	600	2.00	1415
9	2.30	1710	4.00	4090	10.00	19800	2.80	2285	1.00	660	0.30	320	1.80	1240	1.20	790	1.50	1005	5.40	6780	0.80	545	2.20	1605
10	4.60	5165	3.50	3280	7.30	11770	2.80	2285	0.80	545	1.30	860	1.60	1080	1.30	860	1.40	935	3.40	3125	0.20	280	2.40	1820
11	4.60	5165	3.00	2550	8.40	15000	2.70	2160	0.70	490	0.90	600	1.40	935	1.00	660	1.90	1325	2.80	2285	0.10	250	2.00	1415
12	4.50	4980	3.70	3590	8.50	15300	2.70	2160	0.70	490	0.80	545	1.80	1240	0.70	490	2.50	1930	2.60	2040	0.00	220	1.00	660
13	3.90	3920	4.40	4795	6.30	8990	3.80	3750	0.60	440	0.80	545	1.50	1005	0.60	440	2.20	1605	2.20	1605	0.80	545	1.80	1240
14	3.90	3920	4.10	4260	5.30	6560	3.50	3280	0.80	545	1.00	660	1.10	720	0.50	400	1.50	1005	1.90	1325	0.40	360	1.90	1325
15	3.80	3750	3.80	3750	4.50	4980	5.30	6560	0.70	490	1.80	1240	0.80	545	0.30	320	1.40	935	1.80	1240	0.10	250	2.40	1820
16	4.20	4435	3.80	3750	4.10	4260	5.30	6560	0.60	440	2.10	1505	0.70	490	0.50	400	1.00	660	1.60	1080	0.30	320	2.60	2040
17	4.20	4435	3.50	3280	3.80	3750	4.70	5350	0.60	440	1.40	935	0.60	440	0.50	400	1.00	660	1.60	1080	7.30	11770	2.70	2160
18	4.10	4260	3.20	2830	3.50	3280	4.00	4090	0.50	400	1.00	660	1.30	860	0.90	600	4.00	4090	1.80	1240	8.50	15300	2.80	2285
19	3.60	3435	2.60	2040	3.20	2830	3.60	3435	0.50	400	1.00	660	5.40	6780	0.60	440	2.60	2040	2.60	2040	6.50	9520	2.70	2160
20	3.60	3435	7.60	12640	3.00	2550	3.20	2830	0.40	360	1.00	660	3.40	3125	0.70	490	2.10	1505	1.90	1325	4.40	4795	2.80	2285
21	3.30	2975	7.50	12350	3.10	2690	3.00	2550	0.40	360	1.70	1160	3.20	2830	0.40	360	1.90	1325	2.20	1605	3.50	3280	3.10	2690
22	3.00	2550	7.20	11480	3.80	3750	2.80	2285	0.20	280	1.40	935	3.00	2550	1.00	660	1.70	1160	2.00	1415	2.90	2415	3.00	2550
23	3.00	2550	6.80	10335	3.60	3435	2.70	2160	0.20	280	3.50	3280	2.80	2285	0.40	360	1.40	935	1.40	935	2.70	2160	3.30	2975
24	2.60	2040	7.40	12060	6.90	10615	2.50	1930	0.50	400	5.00	5930	2.80	2285	0.90	600	1.30	860	1.10	720	2.60	2040	2.90	2415
25	2.30	1710	7.30	11770	5.20	6340	2.00	1415	0.80	545	3.40	3125	2.30	1710	0.50	400	1.10	720	1.00	660	2.70	2160	3.10	2690
26	2.70	2160	7.00	10900	4.50	4980	2.00	1415	0.60	440	3.00	2550	2.00	1415	1.00	660	1.30	860	1.00	660	2.60	2040	3.00	2550
27	2.60	2040	6.70	10060	3.90	3920	1.90	1325	0.50	400	2.60	2040	1.80	1240	0.90	600	1.00	660	1.20	790	2.60	2040	2.90	2415
28	2.60	2040	9.50	18300	3.50	3280	1.50	1005	1.00	660	2.00	1415	1.60	1080	1.50	1005	0.50	400	1.50	1005	2.20	1605	2.60	2040
29	4.30	4615	....	.....	3.00	2550	1.50	1005	0.80	545	2.00	1415	1.70	1160	1.60	1080	0.70	490	0.80	545	2.00	1415	2.30	1710
30	6.50	9520	....	.....	2.90	2415	1.40	935	0.80	545	2.10	1505	1.50	1005	2.90	2415	0.60	440	0.90	600	2.00	1415	2.10	1505
31	7.70	12930	....	.....	2.90	2415	....	....	0.60	440	....	....	2.60	2040	2.70	2160	....	...	0.80	545	....	....	2.10	1505

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1904.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.00	1415	1.90	1325	8.00	13800	8.70	15900	4.20	4435	3.50	3280	2.00	1415	1.80	1240	1.00	660	0.80	545	0.90	600	-0.30	145
2	2.80	2285	1.80	1240	6.00	8215	11.90	25780	4.00	4090	3.00	2550	3.30	2975	1.70	1160	0.70	490	1.40	935	0.70	490	-0.40	130
3	2.60	2040	2.00	1415	8.20	14400	7.00	10900	3.50	3280	2.60	2040	1.70	1160	1.50	1005	0.60	440	1.20	790	0.50	400	-0.40	130
4	2.40	1820	1.90	1325	11.50	24500	5.60	7240	3.00	2550	2.60	2040	1.50	1005	1.30	860	1.00	660	1.50	1005	0.30	320	-0.20	165
5	2.00	1415	1.80	1240	6.80	10335	4.80	5540	2.90	2415	2.40	1820	1.40	935	1.30	860	0.70	490	1.20	790	0.30	320	-0.30	145
6	1.90	1325	1.60	1080	5.20	6340	4.00	4090	2.80	2285	2.60	2040	2.60	2040	0.50	400	0.60	440	0.80	545	0.60	440	-0.30	145
7	1.80	1240	3.00	2550	8.70	15900	3.80	3750	2.50	1930	2.60	2040	4.10	4260	0.40	360	0.50	400	0.70	490	0.40	360	-0.40	130
8	1.80	1240	9.80	19200	12.00	26100	3.60	3435	2.40	1820	2.20	1605	3.30	2975	0.30	320	0.50	400	0.60	440	0.30	320	-0.40	130
9	1.70	1160	6.00	8215	7.00	10900	3.20	2830	2.40	1820	2.30	1710	3.30	2975	0.10	250	0.40	360	0.70	490	0.20	280	-0.40	130
10	1.60	1080	4.50	4980	6.60	9790	4.80	5540	2.20	1605	2.60	2040	7.90	13510	0.10	250	0.30	320	....	...	0.10	250	-0.40	130
11	1.60	1080	3.00	2550	4.50	4980	4.60	5165	2.00	1415	2.80	2285	7.50	12350	0.30	320	0.30	320	0.60	440	0.70	490	-0.40	130
12	1.40	935	2.90	2415	4.00	4090	4.00	4090	1.90	1325	2.20	1605	5.00	5930	0.50	400	0.40	360	0.50	400	0.40	360	a	....
13	1.40	935	2.90	2415	3.60	3435	3.60	3435	1.60	1080	1.90	1325	5.00	5930	0.30	320	0.30	320	1.50	1005	0.20	280	a	....
14	1.50	1005	2.80	2285	3.20	2830	3.50	3280	1.50	1005	2.10	1505	4.10	4260	0.50	400	0.20	280	1.80	1240	0.10	250	a	....
15	1.40	935	2.60	2040	3.00	2550	3.50	3280	2.60	2040	2.60	2040	3.40	3125	0.30	320	0.20	280	1.70	1160	0.00	220	a	....
16	1.40	935	2.40	1820	2.80	2285	3.00	2550	2.80	2285	2.80	2285	3.00	2550	0.20	280	0.30	320	1.60	1080	-0.10	190	a	....
17	1.30	860	2.00	1415	2.60	2040	3.50	3280	2.50	1930	2.50	1930	2.80	2285	0.60	440	0.20	280	1.20	790	-0.20	165	a	....
18	1.20	790	2.00	1415	2.00	1415	3.00	2550	2.50	1930	2.00	1415	2.50	1930	0.40	360	0.20	280	1.10	720	-0.30	145	a	....
19	1.00	660	3.00	2550	2.60	2040	2.80	2285	7.00	10900	1.80	1240	2.40	1820	0.20	280	0.10	250	0.50	400	-0.30	145	a	....
20	1.00	660	2.90	2415	3.00	2550	2.70	2160	6.20	8730	1.70	1160	2.40	1820	0.30	320	0.00	220	0.40	360	-0.40	130	a	....
21	1.50	1005	2.80	2285	3.90	3920	2.60	2040	4.80	5540	1.60	1080	1.50	1005	1.00	660	-0.10	190	0.30	320	-0.40	130	a	....
22	6.10	8470	3.50	3280	3.40	3125	2.40	1820	4.00	4090	2.80	2285	1.40	935	2.00	1415	-0.20	165	0.60	440	-0.40	130	a	....
23	12.50	27750	3.50	3280	4.60	5165	2.20	1605	3.50	3280	2.50	1930	1.30	860	2.00	1415	-0.30	145	2.70	2160	0.00	220	a	....
24	8.50	15300	3.40	3125	6.00	8215	2.00	1415	4.00	4090	2.40	1820	1.30	860	2.80	2285	-0.30	145	2.40	1820	-0.20	165	2.40	1820
25	6.00	8215	3.30	2975	5.50	7010	2.30	1710	3.90	3920	2.30	1710	1.20	790	2.00	1415	-0.20	165	2.20	1605	-0.30	145	2.60	2040
26	5.00	5930	3.00	2550	7.50	12350	3.80	3750	3.30	2975	2.00	1415	1.20	790	2.00	1415	-0.20	165	2.00	1415	-0.40	130	2.00	1415
27	4.00	4090	3.00	2550	7.50	12350	3.50	3280	3.60	3435	1.80	1240	1.10	720	1.80	1240	1.70	1160	1.50	1005	-0.40	130	2.60	2040
28	3.50	3280	2.90	2415	5.80	7715	4.30	4615	3.80	3750	1.80	1240	1.10	720	1.60	1080	1.50	1005	1.40	935	-0.20	165	6.90	10615
29	3.00	2550	3.00	2550	5.80	7715	4.80	5540	3.00	2550	1.90	1325	1.50	1005	1.50	1005	1.00	660	1.30	860	0.00	220	4.70	5350
30	2.50	1930	....	....	4.00	4090	4.90	5730	2.80	2285	1.70	1160	2.10	1505	1.40	935	0.90	600	1.10	720	-0.20	165	3.30	2975
31	2.00	1415	....	....	3.60	3435	....	....	2.80	2285	....	....	1.90	1325	1.00	660	....	...	1.00	660	....	...	3.00	2550

a. Frozen.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1905.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.00	2550	3.70	3590	0.40	360	4.00	4090	2.40	1820	1.30	860
2	2.90	2415	3.50	3280	0.30	320	3.50	3280	2.30	1710	1.10	720
3	3.10	2690	3.20	2830	0.20	280	3.00	2550	2.00	1415	1.00	660
4	2.80	2285	3.00	2550	0.10	250	2.80	2285	1.90	1325	0.80	545
5	2.70	2160	2.80	2285	0.00	220	2.40	1820	1.90	1325	0.80	545
6	2.60	2040	2.60	2040	0.00	220	2.20	1605	1.90	1325	0.70	490
7	2.50	1930	2.50	1930	-0.10	190	2.00	1415	1.80	1240	2.60	2040
8	2.40	1820	2.40	1820	0.00	220	1.90	1325	1.60	1080	2.60	2040
9	2.40	1820	2.40	1820	6.00	8215	1.80	1240	1.50	1005	2.40	1820
10	2.30	1710	2.50	1930	7.00	10900	1.60	1080	1.40	935	2.20	1605
11	5.00	5930	2.20	1605	6.50	9520	1.40	935	1.40	935	2.20	1605
12	4.80	5540	2.00	1415	3.50	3280	2.50	1930	1.40	935	2.60	2040
13	7.50	12350	2.00	1415	3.00	2550	2.00	1415	2.80	2285	2.20	1605
14	8.00	13800	1.70	1160	2.80	2285	1.90	1325	2.40	1820	2.10	1505
15	7.50	12350	1.50	1005	2.70	2160	1.80	1240	2.80	2285	2.00	1415
16	7.00	10900	1.20	790	2.60	2040	1.60	1080	3.00	2550	2.20	1605
17	6.80	10335	1.00	660	3.00	2550	1.40	935	2.80	2285	2.20	1605
18	6.70	10060	0.80	545	7.40	12060	1.30	860	2.70	2160	3.00	2550
19	6.50	9520	0.60	440	10.80	22280	1.20	790	2.60	2040	2.80	2285
20	6.00	8215	0.50	400	16.00	39300	1.00	660	2.50	1930	2.40	1820
21	5.20	6340	0.40	360	11.00	22900	2.50	1930	2.20	1605	2.40	1820
22	4.90	5730	0.30	320	9.60	18600	4.30	4615	2.20	1605	3.30	2975
23	4.80	5540	0.20	280	7.70	12930	3.80	3750	2.10	1505	4.00	4090
24	4.60	5165	0.10	250	6.80	10335	3.20	2830	2.00	1415	3.20	2830
25	4.60	5165	0.10	250	7.30	11770	3.00	2550	1.90	1325	2.80	2285
26	4.50	4980	0.00	220	7.30	11770	2.90	2415	1.80	1240	2.60	2040
27	4.30	4615	-0.10	190	6.80	10335	2.80	2285	1.60	1080	2.40	1820
28	4.20	4435	0.30	320	6.20	8730	2.60	2040	1.50	1005	....	....
29	4.10	4260	....	...	5.80	7715	2.50	1930	1.40	935	2.00	1415
30	4.00	4090	....	...	5.20	6340	2.50	1930	1.40	935	2.00	1415
31	3.90	3920	....	...	5.00	5930	....	....	1.30	860	....	....

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.90	1325	2.50	1930	1.00	660	0.90	600	2.40	1820	5.00	5930
2	2.20	1605	2.00	1415	0.80	545	0.70	490	2.80	2285	4.00	4090
3	....	....	1.50	1005	1.50	1005	2.00	1415	2.50	1930	a 8.00	13800
4	3.20	2830	1.10	720	1.20	790	1.80	1240	2.40	1820	8.90	16500
5	5.70	7475	1.00	660	1.00	660	2.00	1415	2.20	1605	6.60	9790
6	3.50	3280	1.00	660	0.80	545	1.90	1325	2.50	1930	4.60	5165
7	3.30	2975	0.90	600	0.80	545	1.80	1240	3.50	3280	4.00	4090
8	2.80	2285	1.30	860	0.60	440	1.80	1240	3.00	2550	3.50	3280
9	2.70	2160	1.00	660	0.50	400	1.50	1005	2.80	2285	3.40	3125
10	2.00	1415	0.90	600	0.30	320	1.40	935	2.70	2160	3.00	2550
11	2.00	1415	0.80	545	1.50	1005	1.40	935	2.70	2160	2.90	2415
12	2.40	1820	0.80	545	6.40	9255	6.00	8215	2.60	2040	2.80	2285
13	2.70	2160	1.50	1005	4.00	4090	4.00	4090	2.60	2040	2.70	2160
14	4.20	4435	2.00	1415	3.00	2550	3.70	3590	2.50	1930	2.60	2040
15	3.50	3280	1.90	1325	2.80	2285	3.20	2830	2.50	1930	2.40	1820
16	2.80	2285	2.60	2040	2.60	2040	3.00	2550	2.40	1820	2.30	1710
17	2.60	2040	3.00	2550	2.50	1930	2.80	2285	2.40	1820	2.00	1415
18	2.20	1605	2.00	1415	2.40	1820	2.60	2040	2.30	1710	1.90	1325
19	2.00	1415	1.90	1325	2.30	1710	3.00	2550	1.90	1325	1.90	1325
20	1.90	1325	1.80	1240	2.00	1415	5.20	6340	1.80	1240	1.80	1240
21	1.80	1240	1.70	1160	2.00	1415	5.50	7010	1.70	1160	1.90	1325
22	1.60	1080	1.60	1080	1.90	1325	4.40	4795	1.70	1160	4.90	5730
23	1.50	1005	2.80	2285	1.80	1240	3.80	3750	1.60	1080	4.20	4435
24	1.50	1005	2.40	1820	1.70	1160	3.50	3280	1.60	1080	4.00	4090
25	1.00	660	2.20	1605	1.60	1080	3.00	2550	1.70	1160	3.30	2975
26	1.00	660	2.00	1415	1.50	1005	2.80	2285	1.60	1080	2.80	2285
27	0.90	600	2.00	1415	1.40	935	2.70	2160	1.50	1005	2.60	2040
28	0.90	600	1.90	1325	1.20	790	2.60	2040	1.50	1005	2.50	1930
29	0.80	545	1.40	935	1.20	790	2.50	1930	2.00	1415	3.00	2550
30	2.40	1820	1.20	790	1.00	660	2.40	1820	6.40	9255	6.10	8470
31	3.00	2550	1.20	790	....	....	2.20	1605	....	....	4.50	4980

a. Max. 9.3 = 17700 sec.-ft.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1906.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.90	3920	3.00	2550	2.10	1505	5.60	7240	2.10	1505	2.00	1415	1.00	660	-0.70	100	0.40	360	0.40	360	2.50	1930	1.90	1325
2	3.50	3280	2.80	2285	2.00	1415	5.00	5930	2.00	1415	2.00	1415	0.80	545	-0.70	100	0.40	360	1.60	1080	2.50	1930	1.80	1240
3	3.40	3125	2.60	2040	2.00	1415	4.30	4615	2.00	1415	1.90	1325	0.60	440	-0.70	100	0.60	440	1.00	660	2.00	1415	1.80	1240
4	3.60	3435	4.00	4090	2.40	1820	4.00	4090	2.50	1930	1.80	1240	0.60	440	-0.70	100	2.00	1415	0.80	545	2.00	1415	2.50	1930
5	5.00	5930	3.80	3750	2.50	1930	4.00	4090	2.50	1930	1.80	1240	0.50	400	-0.80	90	1.80	1240	0.60	440	1.90	1325	2.50	1930
6	4.00	4090	3.70	3590	2.40	1820	4.80	5540	2.30	1710	1.70	1160	0.40	360	-0.80	90	1.70	1160	0.70	490	1.70	1160	2.80	2285
7	3.60	3435	3.60	3435	2.40	1820	4.50	4980	2.30	1710	1.80	1240	0.30	320	-0.60	110	1.60	1080	1.50	1005	1.70	1160	7.00	10900
8	3.50	3280	3.60	3435	2.30	1710	4.00	4090	2.20	1605	2.20	1605	0.30	320	-0.60	110	1.50	1005	2.80	2285	1.40	935	4.50	4980
9	3.40	3125	3.60	3435	3.00	2550	3.80	3750	2.20	1605	2.00	1415	0.20	280	-0.40	130	1.40	935	2.60	2040	1.20	790	4.30	4615
10	3.30	2975	3.40	3125	2.80	2285	5.50	7010	2.80	2285	2.00	1415	0.10	250	1.50	1005	1.00	660	2.40	1820	1.00	660	3.80	3750
11	3.20	2830	3.20	2830	2.60	2040	7.70	12930	2.60	2040	1.80	1240	0.00	220	1.00	660	0.80	545	2.60	2040	1.00	660	4.50	4980
12	3.00	2550	3.20	2830	2.50	1930	5.50	7010	2.50	1930	1.70	1160	0.00	220	1.50	1005	0.60	440	2.50	1930	1.20	790	4.50	4980
13	3.00	2550	3.10	2690	2.40	1820	4.70	5350	2.40	1820	1.60	1080	-0.10	190	1.00	660	0.50	400	2.40	1820	1.00	660	3.70	3590
14	2.90	2415	3.10	2690	2.40	1820	4.00	4090	2.40	1820	1.60	1080	-0.20	165	0.80	545	0.80	545	2.20	1605	0.90	600	3.40	3125
15	2.90	2415	3.00	2550	2.30	1710	5.30	6560	2.20	1605	1.50	1005	-0.20	165	0.70	490	0.70	490	2.00	1415	0.80	545	3.40	3125
16	2.50	1930	2.90	2415	2.20	1605	5.00	5930	2.50	1930	1.50	1005	-0.30	145	0.60	440	0.50	400	2.00	1415	1.50	1005	6.00	8215
17	2.50	1930	2.90	2415	2.00	1415	4.30	4615	2.40	1820	1.20	790	-0.30	145	0.50	400	0.40	360	1.80	1240	1.00	660	3.40	3125
18	2.60	2040	2.80	2285	2.00	1415	3.80	3750	2.20	1605	1.10	720	0.00	220	0.50	400	0.40	360	1.70	1160	1.50	1005	3.20	2830
19	3.00	2550	2.80	2285	1.90	1325	3.20	2830	2.20	1605	1.00	660	-0.10	190	0.50	400	0.30	320	1.50	1005	2.50	1930	3.10	2690
20	3.00	2550	2.70	2160	1.90	1325	3.00	2550	2.10	1505	1.00	660	-0.20	165	0.60	440	0.30	320	1.50	1005	2.80	2285	3.00	2550
21	2.90	2415	2.80	2285	1.80	1240	2.90	2415	2.00	1415	0.90	600	-0.30	145	2.00	1415	0.30	320	2.00	1415	3.00	2550	2.80	2285
22	2.90	2415	2.70	2160	1.80	1240	2.80	2285	2.00	1415	0.90	600	-0.30	145	1.20	790	0.20	280	1.80	1240	3.70	3590	2.60	2040
23	6.00	8215	2.60	2040	1.70	1160	2.70	2160	1.90	1325	1.00	660	-0.40	130	1.00	660	0.50	400	1.70	1160	3.00	2550	2.50	1930
24	7.00	10900	2.60	2040	1.60	1080	2.70	2160	1.80	1240	1.10	720	-0.40	130	0.90	600	0.40	360	1.50	1005	2.60	2040	2.30	1710
25	6.00	8215	2.40	1820	1.40	935	2.60	2040	1.70	1160	1.00	660	-0.40	130	0.80	545	0.30	320	1.50	1005	2.50	1930	2.10	1505
26	4.60	5165	2.40	1820	1.40	935	2.50	1930	1.60	1080	0.90	600	-0.50	120	0.80	545	0.30	320	1.80	1240	2.50	1930	2.30	1710
27	4.00	4090	2.50	1930	2.00	1415	2.40	1820	2.00	1415	0.80	545	-0.50	120	0.70	490	0.50	400	1.60	1080	2.40	1820	2.00	1415
28	3.50	3280	2.30	1710	a6.50	9520	2.40	1820	2.80	2285	0.60	440	-0.60	110	0.70	490	0.40	360	1.50	1005	2.20	1605	2.00	1415
29	3.20	2830	....	....	6.20	8730	2.30	1710	2.60	2040	0.50	400	-0.60	110	0.60	440	0.40	360	2.00	1415	2.00	1415	1.90	1325
30	3.00	2550	....	....	4.00	4090	2.30	1710	2.40	1820	0.40	360	-0.60	110	0.50	400	0.50	400	2.40	1820	2.00	1415	1.80	1240
31	2.80	2285	....	....	5.20	6340	....	....	2.20	1605	....	...	-0.60	110	0.50	400	....	...	2.00	1415	....	....	2.80	2285

a. Max. 8.0 = 13800 sec.-ft.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1907.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.50	7010	2.70	2160	3.20	2830	3.80	3750	3.50	3280	2.30	1710	1.80	1240	0.60	440	-0.70	100	1.60	1080	2.20	1605	0.90	600
2	4.50	4980	6.00	8215	3.20	2830	3.40	3125	3.30	2975	2.40	1820	3.00	2550	0.50	400	-0.70	100	1.50	1005	2.00	1415	0.90	600
3	3.40	3125	8.00	13800	3.50	3280	3.00	2550	3.00	2550	3.00	2550	2.80	2285	0.30	320	-0.40	130	1.50	1005	3.00	2550	0.80	545
4	4.50	4980	8.00	13800	3.40	3125	2.80	2285	3.00	2550	2.70	2160	2.50	1930	0.10	250	-0.20	165	1.80	1240	4.80	5540	2.00	1415
5	5.50	7010	7.50	12350	3.40	3125	2.60	2040	3.50	3280	2.60	2040	2.40	1820	0.00	220	-0.20	165	3.70	3590	3.70	3590	1.80	1240
6	4.20	4435	7.30	11770	3.30	2975	2.60	2040	3.00	2550	3.50	3280	2.20	1605	0.00	220	-0.30	145	3.40	3125	3.20	2830	1.80	1240
7	3.50	3280	7.00	10900	3.20	2830	2.50	1930	2.90	2415	3.40	3125	2.00	1415	-0.10	190	-0.30	145	2.80	2285	3.40	3125	1.70	1160
8	4.20	4435	6.50	9520	3.00	2550	2.50	1930	2.80	2285	3.00	2550	1.90	1325	-0.20	165	-0.40	130	2.60	2040	3.20	2830	1.50	1005
9	7.00	10900	6.00	8215	3.00	2550	2.40	1820	3.40	3125	2.80	2285	1.90	1325	-0.20	165	-0.40	130	2.80	2285	3.00	2550	1.40	935
10	5.00	5930	5.60	7240	2.90	2415	2.30	1710	2.80	2285	2.60	2040	1.60	1080	-0.30	145	-0.50	125	2.70	2160	2.90	2415	1.80	1240
11	4.50	4980	5.20	6340	2.80	2285	2.20	1605	2.60	2040	2.40	1820	1.50	1005	-0.30	145	1.00	660	2.60	2040	2.70	2160	2.00	1415
12	3.80	3750	5.00	5930	2.80	2285	2.00	1415	2.60	2040	2.60	2040	1.40	935	-0.40	130	2.80	2285	2.40	1820	2.60	2040	3.00	2550
13	4.00	4090	5.00	5930	3.50	3280	2.00	1415	2.50	1930	2.80	2285	1.40	935	-0.40	130	2.60	2040	2.40	1820	2.60	2040	2.80	2285
14	4.00	4090	4.80	5540	a8.00	13800	1.90	1325	2.40	1820	3.00	2550	1.60	1080	-0.50	120	2.50	1930	2.30	1710	2.50	1930	2.60	2040
15	6.00	8215	4.80	5540	8.50	15300	1.80	1240	2.30	1710	3.00	2550	1.40	935	-0.50	120	2.30	1710	2.10	1505	2.30	1710	3.00	2550
16	4.80	5540	4.60	5165	6.90	10615	1.80	1240	2.40	1820	2.80	2285	1.30	860	-0.50	120	2.20	1605	2.00	1415	2.20	1605	2.90	2415
17	4.00	4090	4.50	4980	6.50	9520	1.70	1160	2.80	2285	2.60	2040	1.20	790	-0.50	120	2.20	1605	1.70	1160	2.00	1415	2.70	2160
18	3.50	3280	4.30	4615	5.80	7715	1.70	1160	2.60	2040	2.40	1820	1.80	1240	-0.60	110	2.10	1505	1.60	1080	1.90	1325	2.70	2160
19	3.50	3280	4.30	4615	5.50	7010	1.60	1080	2.40	1820	2.30	1710	1.60	1080	-0.60	110	1.90	1325	1.60	1080	1.80	1240	2.60	2040
20	7.00	10900	5.00	5930	6.50	9520	1.60	1080	2.30	1710	2.00	1415	1.50	1005	-0.70	100	1.80	1240	1.40	935	1.70	1160	2.50	1930
21	6.50	9520	4.80	5540	6.00	8215	1.50	1005	2.20	1605	1.80	1240	1.40	935	-0.70	100	1.60	1080	1.40	935	1.70	1160	2.50	1930
22	6.00	8215	4.60	5165	5.80	7715	1.30	860	2.00	1415	1.80	1240	1.40	935	-0.40	130	1.60	1080	1.80	1240	1.60	1080	2.40	1820
23	3.60	3435	4.30	4615	5.50	7010	1.30	860	1.90	1325	1.70	1160	1.30	860	-0.40	130	1.50	1005	1.60	1080	1.60	1080	3.00	2550
24	3.50	3280	4.00	4090	5.40	6780	2.80	2285	1.60	1080	1.80	1240	1.00	660	-0.50	120	1.40	935	1.50	1005	1.50	1005	8.00	13800
25	3.30	2975	3.70	3590	4.80	5540	4.20	4435	1.50	1005	1.70	1160	0.80	545	-0.40	130	1.40	935	1.30	860	1.40	935	7.00	10900
26	3.20	2830	3.50	3280	4.00	4090	3.60	3435	1.40	935	1.90	1325	0.60	440	-0.50	120	1.30	860	1.10	720	1.40	935	4.00	4090
27	3.00	2550	3.50	3280	4.30	4615	6.60	9790	1.80	1240	1.90	1325	0.50	400	-0.50	120	1.20	790	1.00	660	1.30	860	3.40	3125
28	3.00	2550	3.30	2975	5.10	6130	5.00	5930	3.00	2550	1.80	1240	0.50	400	-0.40	130	1.20	790	1.60	1080	1.20	790	3.40	3125
29	2.90	2415	....	....	5.00	5930	4.20	4435	2.80	2285	1.80	1240	0.60	440	-0.50	120	1.10	720	3.50	3280	1.00	660	5.00	5930
30	2.80	2285	....	....	4.40	4795	3.90	3920	2.70	2160	1.60	1080	0.70	490	-0.60	110	1.60	1080	2.90	2415	1.00	660	4.00	4090
31	2.80	2285	....	....	4.00	4090	....	....	2.50	1930	....	....	0.70	490	-0.70	100	....	....	2.50	1930	....	...	4.30	4615

a. Max. 11 A. M., 12.0 = 26100 sec.-ft.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1908.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.00	4090	3.70	3590	4.50	4980	4.90	5730	3.50	3280	4.60	5165
2	3.50	3280	3.60	3435	5.00	5930	4.50	4980	4.50	4980	4.00	4090
3	3.30	2975	3.40	3125	8.50	15300	4.00	4090	4.30	4615	3.80	3750
4	3.00	2550	3.40	3125	6.20	8730	3.80	3750	4.00	4090	3.40	3125
5	2.80	2285	3.30	2975	5.10	6130	3.60	3435	3.80	3750	3.00	2550
6	3.40	3125	3.30	2975	4.60	5165	3.00	2550	3.70	3590	2.90	2415
7	3.20	2830	3.20	2830	6.00	8215	3.40	3125	4.50	4980	2.70	2160
8	3.00	2550	3.20	2830	5.60	7240	3.00	2550	7.00	10900	2.50	1930
9	2.90	2415	3.00	2550	5.00	5930	4.60	5165	5.50	7010	2.40	1820
10	2.70	2160	3.00	2550	4.70	5350	5.80	7715	5.00	5930	2.30	1710
11	2.60	2040	2.90	2415	4.30	4615	4.20	4435	4.30	4615	2.30	1710
12	5.00	5930	2.90	2415	3.70	3590	4.00	4090	4.00	4090	2.20	1605
13	4.20	4435	3.10	2690	5.50	7010	3.80	3750	2.60	2040	2.10	1505
14	4.50	4980	6.00	8215	8.80	16200	3.50	3280	2.50	1930	2.00	1415
15	4.00	4090	a6.20	8730	8.50	15300	3.10	2690	3.00	2550	2.20	1605
16	3.80	3750	11.00	22900	10.50	21350	4.80	5540	3.20	2830	2.50	1930
17	3.60	3435	6.60	9790	7.40	12060	4.50	4980	4.00	4090	2.50	1930
18	3.60	3435	5.80	7715	6.80	10335	4.00	4090	4.20	4435	2.40	1820
19	3.50	3280	5.30	6560	b10.30	20730	4.50	4980	3.70	3590	2.30	1710
20	3.40	3125	4.80	5540	9.00	16800	4.80	5540	6.80	10335	2.30	1710
21	3.40	3125	4.40	4795	6.00	8215	4.50	4980	5.80	7715	2.10	1505
22	3.30	2975	4.20	4435	5.00	5930	4.00	4090	5.00	5930	2.00	1415
23	3.20	2830	4.00	4090	4.50	4980	3.80	3750	4.80	5540	2.00	1415
24	3.00	2550	3.90	3920	4.50	4980	3.20	2830	4.50	4980	1.90	1325
25	3.00	2550	3.80	3750	4.30	4615	3.00	2550	4.30	4615	1.70	1160
26	2.90	2415	3.60	3435	4.20	4435	2.90	2415	4.00	4090	1.50	1005
27	3.50	3280	3.40	3125	4.20	4435	3.40	3125	3.90	3920	1.50	1005
28	6.00	8215	3.30	2975	5.50	7010	3.20	2830	4.00	4090	1.40	935
29	4.00	4090	5.00	5930	6.00	8215	3.00	2550	3.70	3590	1.30	860
30	3.80	3750	....	....	5.60	7240	2.90	2415	4.50	4980	1.30	860
31	3.80	3750	....	....	5.20	6340	....	....	5.00	5930	....	...

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.20	790	1.50	1005	0.10	250	-0.90	80	-0.90	80	-0.40	130
2	1.20	790	1.30	860	0.10	250	-0.90	80	-0.90	80	-0.40	130
3	2.00	1415	1.20	790	0.00	220	-0.90	80	-1.00	70	-0.50	120
4	2.10	1505	1.20	790	-0.10	190	-0.90	80	-1.00	70	-0.50	120
5	2.20	1605	1.10	720	-0.10	190	-0.90	80	-1.00	70	-0.50	120
6	2.10	1505	1.40	935	-0.20	165	-1.00	70	-1.00	70	-0.60	110
7	2.10	1505	1.80	1240	-0.20	165	-1.00	70	-1.00	70	-0.60	110
8	2.20	1605	1.70	1160	-0.30	145	-1.00	70	-1.00	70	-0.60	110
9	2.10	1505	1.60	1080	-0.30	145	-1.00	70	-1.10	60	-0.60	110
10	2.00	1415	1.50	1005	-0.30	145	-1.00	70	-1.10	60	-0.70	100
11	2.00	1415	1.30	860	-0.40	130	-1.00	70	-0.80	90	-0.70	100
12	1.80	1240	1.20	790	-0.40	130	-1.00	70	-0.20	165	-0.70	100
13	1.50	1005	1.20	790	-0.40	130	-1.00	70	-0.20	165	-0.70	100
14	2.00	1415	1.10	720	-0.50	120	-1.10	60	-0.30	145	-0.80	90
15	2.40	1820	1.00	660	-0.50	120	-1.10	60	-0.30	145	-0.80	90
16	2.20	1605	0.80	545	-0.50	120	-1.10	60	-0.30	145	-0.80	90
17	2.00	1415	0.80	545	-0.60	110	-1.10	60	-0.40	130	-0.80	90
18	1.90	1325	0.80	545	-0.60	110	-1.10	60	-0.40	130	-0.60	110
19	2.00	1415	1.00	660	-0.60	110	-1.10	60	-0.40	130	3.00	2550
20	1.90	1325	1.00	660	-0.60	110	-1.10	60	-0.40	130	3.40	3125
21	1.80	1240	0.90	600	-0.70	100	-1.10	60	-0.40	130	2.90	2415
22	8.80	16200	0.80	545	-0.70	100	-1.10	60	-0.50	120	2.60	2040
23	3.80	3750	0.70	490	-0.70	100	-1.10	60	-0.50	120	2.40	1820
24	2.80	2285	0.70	490	-0.80	90	-1.10	60	-0.50	120	2.40	1820
25	2.50	1930	0.60	440	-0.80	90	-1.10	60	-0.50	120	2.20	1605
26	2.40	1820	0.60	440	-0.80	90	-1.10	60	-0.50	120	2.10	1505
27	2.20	1605	0.40	360	-0.80	90	-1.20	50	-0.60	110	2.10	1505
28	2.10	1505	0.30	320	-0.80	90	-1.20	50	-0.60	110	2.00	1415
29	2.00	1415	0.30	320	-0.80	90	-0.90	80	-0.60	110	1.80	1240
30	2.00	1415	0.20	280	-0.80	90	-0.90	80	-0.60	110	1.80	1240
31	1.90	1325	0.20	280	....	..	-0.90	80	....	...	2.40	1820

a. Max. 5 P. M., 12.0 = 26100 sec.-ft. b. Max. 2 P. M., 11.1 = 23220 sec.-ft.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.80	2285	3.80	3750	4.80	5535	3.50	3280	10.90	24215	0.60	440	0.20	280	0.00	220	–0.40	130	–0.40	130	–0.60	100	–0.60	100
2	2.50	1930	3.60	3435	4.50	4980	3.40	3125	9.00	17265	0.40	360	0.20	280	0.00	220	–0.50	125	–0.40	130	–0.60	100	–0.60	100
3	2.40	1820	3.50	3280	4.40	4795	3.30	2975	7.00	10900	0.40	360	0.10	250	0.00	220	–0.50	125	–0.40	130	–0.60	100	–0.60	100
4	3.00	2550	3.50	3280	4.20	4435	3.20	2830	5.60	7240	0.30	320	0.00	220	–0.20	165	–0.50	125	–0.40	130	–0.60	100	–0.60	100
5	3.40	3125	3.30	2975	4.10	4260	3.20	2830	5.00	5930	0.40	360	0.00	220	–0.20	165	–0.50	125	–0.40	130	–0.60	100	–0.60	100
6	5.50	7010	4.10	4260	4.00	4090	3.00	2550	5.00	5930	0.80	545	0.00	220	–0.20	165	–0.50	125	–0.50	125	–0.60	100	–0.60	100
7	5.60	7240	4.50	4980	4.00	4090	3.70	3590	4.00	4090	0.70	490	0.00	220	–0.30	145	–0.50	125	–0.50	125	–0.60	100	–0.60	100
8	4.40	4795	4.00	4090	3.90	3920	4.40	4795	3.90	3920	0.70	490	0.00	220	–0.30	145	–0.40	130	–0.50	125	–0.60	100	–0.60	100
9	3.90	3920	3.80	3750	4.20	4435	4.20	4435	3.00	2550	0.80	545	0.00	220	–0.30	145	–0.40	130	–0.50	125	–0.50	125	–0.60	100
10	3.70	3590	3.70	3590	5.50	7010	4.60	5165	3.90	3920	0.80	545	0.00	220	–0.40	130	–0.40	130	–0.50	125	–0.50	125	–0.60	100
11	3.50	3280	3.50	3280	5.00	5930	4.30	4615	2.60	2040	1.00	660	0.00	220	–0.40	130	–0.40	130	–0.40	130	–0.60	100	–0.60	100
12	3.40	3125	3.50	3280	4.50	4980	4.20	4435	2.90	2410	0.90	600	0.00	220	–0.40	130	–0.40	130	–0.30	145	–0.60	100	–0.60	100
13	3.40	3125	4.00	4090	4.00	4090	4.00	4090	2.00	1415	0.80	545	0.00	220	–0.40	130	–0.50	125	–0.30	145	–0.60	100	–0.60	100
14	3.30	2975	4.60	5165	3.80	3750	4.90	5730	1.60	1080	0.70	490	0.00	220	–0.40	130	–0.50	125	0.00	220	–0.60	100	–0.40	130
15	3.50	3280	6.00	8215	3.50	3280	5.50	7010	1.00	660	0.60	440	0.00	220	–0.50	125	–0.50	125	0.00	220	–0.60	100	–0.40	130
16	4.00	4090	9.00	16800	3.40	3125	4.40	4795	1.00	660	0.50	400	0.00	220	–0.30	145	–0.30	145	0.00	220	–0.60	100	–0.40	130
17	3.80	3750	8.70	15900	3.20	2830	3.90	3920	1.00	660	0.40	360	0.30	320	0.00	220	–0.30	145	0.00	220	–0.50	125	–0.40	130
18	3.60	3435	7.50	12350	3.00	2550	3.60	3435	1.00	660	0.40	360	0.10	250	0.00	220	–0.30	145	–0.20	165	–0.50	125	–0.40	130
19	3.40	3125	5.50	7010	3.00	2550	3.60	3435	1.00	660	0.30	320	0.00	220	0.00	220	–0.30	145	–0.20	165	–0.50	125	–0.40	130
20	3.30	2975	4.80	5535	2.90	2415	2.00	1415	0.80	545	0.20	280	0.00	220	0.00	220	–0.30	145	–0.20	165	–0.40	130	–0.40	130
21	3.20	2830	4.50	4980	2.80	2285	2.60	2040	0.60	440	0.10	250	0.00	220	0.00	220	–0.40	130	–0.20	165	–0.50	125	–0.40	130
22	3.20	2830	4.20	4435	2.70	2160	3.60	3435	0.60	440	0.10	250	0.00	220	0.00	220	–0.50	125	–0.20	165	–0.60	100	–0.40	130
23	3.60	3435	4.00	4090	2.70	2160	4.20	4435	0.60	440	0.10	250	0.30	320	0.00	220	–0.50	125	–0.40	130	–0.60	100	–0.40	130
24	6.60	9790	7.60	12640	2.50	1930	3.60	3435	0.40	360	0.10	250	3.00	2550	0.00	220	–0.40	130	–0.40	130	–0.60	100	–0.40	130
25	6.00	8215	8.90	16500	3.10	2690	3.00	2550	0.30	320	1.00	660	1.00	660	–0.30	145	–0.40	130	–0.50	125	–0.40	130	–0.40	130
26	5.80	7715	6.90	10615	4.80	5535	2.60	2040	0.20	280	0.60	440	0.30	320	0.00	220	–0.40	130	–0.50	125	–0.40	130	–0.40	130
27	5.10	6130	5.80	7715	4.60	5165	2.00	1415	0.20	280	0.90	600	0.00	220	0.00	220	–0.40	130	–0.60	100	–0.50	125	–0.40	130
28	4.70	5345	5.10	6130	4.50	4980	2.00	1415	0.30	320	0.60	440	0.00	220	–0.20	165	–0.40	130	–0.60	100	–0.60	100	–0.40	130
29	4.30	4615	....	....	4.40	4795	3.00	2550	0.20	280	0.40	360	0.00	220	–0.30	145	–0.40	130	–0.60	100	–0.60	100	–0.40	130
30	4.20	4435	....	....	3.70	3590	12.90	31600	0.60	440	0.20	280	0.20	280	–0.40	130	–0.40	130	–0.60	100	–0.60	100	–0.40	130
31	4.00	4090	....	....	3.50	3280	....	....	0.60	440	....	...	0.00	220	–0.40	130	....	...	–0.60	100	....	...	–0.40	130

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	-0.40	130	2.00	1415	10.80	22280	2.00	1415	3.00	2550	1.90	1325	0.30	320	0.10	250	-0.60	110	0.60	440	-0.40	130	2.60	2040
2	-0.40	130	2.00	1415	9.60	18600	2.00	1415	2.50	1930	2.00	1415	0.30	320	-0.10	190	-0.60	110	0.40	360	-0.40	130	2.20	1605
3	-0.40	130	2.00	1415	10.00	19800	2.00	1415	2.40	1820	1.90	1325	0.30	320	0.00	220	-0.40	130	0.40	360	-0.50	120	2.00	1415
4	-0.40	130	2.00	1415	8.60	15600	2.00	1415	2.50	1930	2.80	2285	0.30	320	0.00	220	-0.40	130	0.30	320	-0.60	110	2.00	1415
5	-0.40	130	1.90	1325	7.60	12640	2.60	2040	2.50	1930	2.60	2040	0.30	320	0.00	220	-0.00	220	0.30	320	-0.60	110	2.00	1415
6	-0.30	145	1.60	1080	7.30	11770	2.70	2160	2.50	1930	2.00	1415	0.30	320	0.00	220	0.00	220	0.40	360	-0.60	110	1.90	1325
7	-0.30	145	1.40	935	7.00	10900	2.80	2285	2.40	1820	2.00	1415	0.30	320	-0.20	165	0.00	220	0.00	220	-0.60	110	1.60	1080
8	-0.30	145	1.40	935	8.00	13800	2.40	1820	2.40	1820	1.90	1325	0.20	280	-0.20	165	0.10	250	-0.40	130	-0.40	130	1.40	935
9	-0.30	145	1.20	790	6.00	8215	2.20	1605	2.30	1710	1.70	1160	0.20	280	-0.30	145	0.10	250	-0.60	110	-0.40	130	1.20	790
10	-0.30	145	1.10	720	6.20	8730	2.00	1415	2.40	1820	1.70	1160	0.20	280	-0.30	145	0.10	250	0.20	280	-0.40	130	1.20	790
11	-0.30	145	1.00	660	5.00	5930	2.00	1415	2.30	1710	1.40	935	0.30	320	-0.30	145	0.10	250	0.00	220	0.60	440	1.00	660
12	-0.30	145	1.00	660	4.60	5165	2.00	1415	2.30	1710	1.40	935	0.30	320	-0.30	145	0.10	250	-0.20	165	1.10	720	1.00	660
13	-0.30	145	1.20	790	4.60	5165	1.40	935	2.10	1505	1.40	935	0.30	320	-0.30	145	0.10	250	-0.40	130	1.60	1080	1.50	1005
14	-0.30	145	1.50	1005	4.30	4615	1.00	660	2.00	1415	1.60	1080	0.20	280	-0.30	145	0.00	220	-0.50	120	1.30	860	1.80	1240
15	-0.30	145	1.40	935	3.80	3750	0.50	400	1.90	1325	1.50	1005	0.20	280	-0.40	130	0.00	220	-0.50	120	1.60	1080	1.20	790
16	-0.30	145	1.40	935	3.60	3435	0.50	400	1.50	1005	1.20	790	0.20	280	-0.40	130	0.00	220	-0.50	120	1.20	790	b 1.20	790
17	-0.30	145	1.50	1005	2.90	2415	0.20	280	1.20	790	1.00	660	0.80	545	-0.40	130	0.00	220	-0.50	120	1.20	790	1.20	790
18	0.00	220	1.50	1005	2.60	2040	1.00	660	1.20	790	1.00	660	0.60	440	-0.50	120	0.00	220	-0.50	120	1.10	720	1.20	790
19	12.00	26100	1.50	1005	2.90	2415	1.10	720	1.20	790	1.00	660	0.60	440	-0.50	120	0.00	220	-0.50	120	1.00	660	1.20	790
20	5.60	7240	1.20	790	2.90	2415	1.40	935	1.20	790	1.00	660	0.50	400	-0.50	120	0.00	220	-0.60	110	1.00	660	1.20	790
21	4.00	4090	1.40	935	2.90	2415	3.00	2550	1.40	935	0.90	600	0.40	360	-0.50	120	0.00	220	-0.60	110	1.00	660	1.20	790
22	8.20	14400	5.60	7240	4.80	5535	3.40	3125	1.20	790	0.60	440	0.30	320	-0.50	120	0.00	220	-0.60	110	1.20	790	1.20	790
23	6.00	8215	5.30	6560	4.60	5165	3.50	3280	1.60	1080	0.60	440	0.30	320	-0.60	110	0.00	220	-0.40	130	1.20	790	1.20	790
24	5.60	7240	2.80	2285	4.60	5165	3.60	3435	2.00	1415	0.50	400	0.30	320	-0.60	110	0.00	220	-0.40	130	1.50	1005	1.20	790
25	4.00	4090	2.90	2415	4.60	5165	3.70	3590	2.20	1605	0.50	400	0.20	280	-0.60	110	0.00	220	-0.40	130	1.90	1325	1.20	790
26	3.00	2550	2.90	2415	4.60	5165	5.70	7475	2.00	1415	0.40	360	0.20	280	-0.60	110	0.20	280	-0.40	130	3.00	2550	1.20	790
27	2.50	1930	3.40	3125	4.50	4980	4.90	5780	2.00	1415	0.30	320	0.20	280	-0.60	110	0.20	280	-0.30	145	2.60	2040	1.20	790
28	2.50	1930	a 13.00	29400	4.50	4980	4.00	4090	1.90	1325	0.30	320	0.20	280	-0.60	110	0.70	490	0.70	490	2.40	1820	1.20	790
29	2.00	1415	.....	.....	3.00	2550	3.50	3280	1.80	1240	0.30	320	0.20	280	-0.60	110	0.90	600	0.80	545	2.60	2040	1.20	790
30	2.00	1415	.....	.....	3.50	3280	3.20	2830	1.90	1325	0.30	320	0.20	280	-0.60	110	0.80	545	0.90	600	2.80	2285	7.00	10900
31	2.00	1415	.....	.....	3.40	3125	....	....	2.00	1415	....	...	0.20	280	-0.60	110	....	...	0.00	220	....	....	5.40	6780

a. Max. 4 P. M. 14.5 = 34250 sec.-ft. b. River frozen Dec. 16–29, measurement taken to top of ice.

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1911.

Day	January		February		March		April		May	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.50	7010	3.90	3920	2.10	1505	3.10	2690	2.40	1820
2	4.30	4615	3.90	3920	2.10	1505	3.50	3280	3.10	2690
3	6.80	10335	3.60	3435	2.10	1505	2.80	2285	2.90	2415
4	5.40	6780	2.80	2285	2.00	1415	2.40	1820	2.40	1820
5	5.00	5930	2.60	2040	1.80	1240	2.90	2415	2.00	1415
6	4.60	5165	2.60	2040	1.80	1240	4.10	4260	2.00	1415
7	3.50	3280	2.60	2040	1.40	935	4.60	5165	1.80	1240
8	3.40	3125	2.40	1820	1.10	720	5.30	6560	1.60	1080
9	3.00	2550	2.00	1415	1.10	720	4.60	5165	1.60	1080
10	2.90	2415	1.90	1325	1.30	860	4.30	4615	1.50	1005
11	2.80	2285	1.60	1080	1.50	1005	4.00	4090	1.50	1005
12	3.40	3125	1.60	1080	2.00	1415	3.60	3435	1.40	935
13	4.00	4090	1.60	1080	2.40	1820	3.30	2975	1.40	935
14	6.60	9790	1.50	1005	2.60	2040	3.10	2690	1.40	935
15	9.60	18600	2.80	2285	2.50	1930	5.60	7240	1.40	935
16	7.00	10900	3.30	2975	2.10	1505	4.90	5730	1.40	935
17	6.20	8730	2.70	2160	1.80	1240	4.60	5165	1.20	790
18	5.70	7475	3.70	3590	2.10	1505	3.60	3435	1.00	660
19	3.00	2550	5.20	6340	3.20	2830	3.20	2830	1.20	790
20	2.90	2415	5.00	5930	2.90	2415	3.40	3125	1.00	660
21	2.90	2415	4.00	4090	2.70	2160	5.10	6130	1.00	660
22	2.80	2285	2.00	1415	3.00	2550	4.20	4435	1.00	660
23	2.60	2040	2.70	2160	3.40	3125	4.70	5350	1.00	660
24	1.90	1325	2.40	1820	3.60	3435	4.40	4795	0.90	600
25	1.60	1080	2.40	1820	3.00	2550	3.60	3435	0.90	600
26	1.60	1080	2.50	1930	3.00	2550	3.40	3125	0.90	600
27	1.50	1005	2.40	1820	2.80	2285	3.10	2690	0.90	600
28	5.90	7965	2.60	2040	5.10	6130	2.70	2160	0.90	600
29	7.10	11190	....	....	4.20	4435	2.50	1930	0.90	600
30	5.00	5930	....	....	3.60	3435	2.70	2160	0.90	600
31	4.60	5165	....	....	3.50	3280	....	....	0.70	490

Day	June		July		August		September	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.70	490	0.50	400	0.40	360	4.00	4090
2	0.70	490	0.50	400	0.50	400	3.20	2830
3	0.50	400	0.40	360	0.20	280	2.70	2160
4	0.50	400	0.40	360	–0.20	165	2.20	1605
5	0.30	320	0.20	280	–0.10	190	2.00	1415
6	0.50	400	0.00	220	–0.40	130	2.00	1415
7	0.40	360	0.00	220	0.00	220	7.20	11480
8	0.40	360	0.00	220	0.00	220	5.00	5930
9	0.20	280	0.00	220	0.00	220	4.30	4615
10	0.20	280	0.00	220	0.00	220	6.80	10335
11	0.60	440	0.00	220	0.00	220	5.20	6340
12	1.00	660	0.20	280	0.00	220	4.20	4435
13	3.60	3435	0.40	360	0.00	220	4.20	4435
14	2.00	1415	0.20	280	0.00	220	2.90	2415
15	1.60	1080	0.00	220	0.00	220	5.40	6780
16	1.00	660	0.00	220	1.20	790	8.00	13800
17	1.00	660	0.00	220	1.90	1325	5.20	6340
18	1.00	660	0.00	220	1.40	935	4.80	5540
19	1.00	660	0.00	220	1.20	790	3.20	2830
20	1.00	660	0.00	220	1.00	660	3.00	2550
21	0.80	545	0.00	220	1.00	660	2.70	2160
22	0.60	440	0.20	280	0.50	400	2.70	2160
23	0.40	360	0.30	320	0.20	280	2.20	1605
24	0.40	360	0.00	220	0.30	320	2.00	1415
25	0.40	360	0.00	220	0.60	440	2.00	1415
26	0.50	400	0.00	220	4.10	4260	2.00	1415
27	0.50	400	0.20	280	3.30	2975	1.70	1160
28	0.50	400	0.20	280	1.80	1240	1.30	860
29	0.80	545	0.20	280	10.30	20730	2.40	1820
30	0.60	440	0.20	280	7.60	12640	5.70	7475
31	....	...	0.30	320	5.00	5930	....	....

Daily Gage Heights and Discharges of Clarion River at Clarion, Pa., for 1901.

Day	November		December		Day	November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.40	360	2.90	2415	17	1.80	1240	5.60	7240
2	0.20	280	2.50	1930	18	1.70	1160	4.50	4980
3	0.10	250	2.50	1930	19	1.70	1160	3.50	3280
4	0.30	320	2.80	2285	20	1.60	1080	3.00	2550
5	0.40	360	2.40	1820	21	0.40	360	2.70	2160
6	0.30	320	2.00	1415	22	0.40	360	2.40	1820
7	0.60	440	1.80	1240	23	0.40	360	2.50	1930
8	0.20	280	2.00	1415	24	2.90	2415	2.80	2285
9	0.00	220	1.90	1325	25	7.20	11480	2.50	1930
10	-0.20	165	3.40	3125	26	5.40	6780	2.40	1820
11	-0.10	190	5.40	6780	27	4.00	4090	2.30	1710
12	0.20	280	4.10	4260	28	3.60	3435	2.10	1505
13	2.00	1415	3.60	3435	29	3.10	2690	2.40	1820
14	1.60	1080	3.40	3125	30	2.80	2285	2.50	1930
15	2.50	1930	10.20	20420	31	....	....	2.50	1930
16	1.90	1325	7.50	12350					

Rating Table for Clarion River at Clarion, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
-1.00	70	1.00	660	3.00	2550	5.00	5930	7.00	10900
-0.90	80	.10	720	.10	2690	.10	6130	.20	11480
-0.80	90	.20	790	.20	2830	.20	6340	.40	12060
-0.70	100	.30	860	.30	2975	.30	6560	.60	12640
-0.60	110	.40	935	.40	3125	.40	6780	.80	13220
-0.50	120	.50	1005	.50	3280	.50	7010	8.00	13800
-0.40	130	.60	1080	.60	3435	.60	7240	.20	14400
-0.30	145	.70	1160	.70	3590	.70	7475	.40	15000
-0.20	165	.80	1240	.80	3750	.80	7715	.60	15600
-0.10	190	.90	1325	.90	3920	.90	7965	.80	16200
0.00	220	2.00	1415	4.00	4090	6.00	8215	9.00	16800
.10	250	.10	1505	.10	4260	.10	8470	.20	17400
.20	280	.20	1605	.20	4435	.20	8730	.40	18000
.30	320	.30	1710	.30	4615	.30	8990	.60	18600
.40	360	.40	1820	.40	4795	.40	9255	.80	19200
.50	400	.50	1930	.50	4980	.50	9520	10.00	19800
.60	440	.60	2040	.60	5165	.60	9790	11.00	22900
.70	490	.70	2160	.70	5350	.70	10060	12.00	26100
.80	545	.80	2285	.80	5540	.80	10335	13.00	29400
.90	600	.90	2415	.90	5730	.90	10615	14.00	32700

Estimated Monthly Discharge of Clarion River at Clarion, Pa.

[Drainage area, 910 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1885					
January 1–26	9255	1325	3532	3.886	3.774
April 3–30	10900	2285	6132	6.739	7.017
May	12350	935	2829	3.109	3.584
June	18600	440	3356	3.688	4.115
July	1930	280	603	0.663	0.764
August	22280	280	4987	5.481	6.319
September	5930	400	1631	1.789	1.999
October	4090	320	1063	1.168	1.346
November	2975	1005	1469	1.618	1.805
December	2975	860	1934	2.125	2.450

Estimated Monthly Discharge of Clarion River at Clarion, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1886					
April	19200	1005	4612	5.068	5.654
May	1325	440	889	0.976	1.125
June	1505	190	441	0.484	0.541
July	1160	165	353	0.388	0.447
August	220	120	140	0.154	0.177
September	2830	110	482	0.529	0.590
October	1605	110	279	0.307	0.355
November	16500	110	2668	2.932	3.271
1887					
February	26100	1710	7883	8.656	9.013
March	9790	935	3469	3.812	4.395
April	5350	790	2438	2.677	2.987
May	5165	860	2230	2.448	2.822
July	4090	90	399	0.438	0.505
August	1160	220	416	0.457	0.527
September	545	145	296	0.325	0.363
October	250	110	157	0.173	0.199
November	1605	110	377	0.414	0.462
1888					
April	19800	1240	4972	5.464	6.096
May	3280	790	1196	1.315	1.516
June	1605	360	802	0.881	0.983
July	545	120	198	0.217	0.250
August	1930	110	467	0.513	0.591
September	400	110	140	0.154	0.172
November	5540	860	2072	2.278	2.542
December	4435	545	1313	1.442	1.662
1889					
January	5165	860	1633	1.794	2.073
March 7–31	7475	1240	3428	3.767	3.502
April	5930	1240	3502	3.848	4.285
November	4795	660	1822	2.009	2.241
December	7010	1080	3138	3.448	3.975
1890					
January	10355	1080	4081	4.489	5.174
February	10060	1415	3827	4.212	4.386
March	6780	1240	3462	3.807	4.389
April	8730	860	3572	3.927	4.382
July	790	100	265	0.292	0.337
August	4090	100	989	1.087	1.253
September	15600	935	3649	4.018	4.483
October	10335	660	3033	3.333	3.842
November	6340	1160	2516	2.764	3.083
1891					
February	29400	2550	6682	7.342	7.645
March	5930	860	2077	2.283	2.632
April	8990	1415	4557	4.999	5.578
May	1415	190	5042	5.549	6.397
June	5165	190	1742	1.914	2.135
July	15300	120	2412	2.649	3.054
November	8215	250	2238	2.462	2.747
December	11770	1415	4469	4.912	5.663

Estimated Monthly Discharge of Clarion River at Clarion, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1892					
February	8215	1605	4153	4.562	4.750
March	14100	1080	3199	3.521	4.059
April	12060	935	3510	3.861	4.308
August	1240	110	3302	3.631	4.186
September	660	120	242	0.267	0.298
October	250	110	148	0.163	0.188
November	1930	145	500	0.549	0.613
1893					
March	11190	2830	6567	7.209	8.311
April	11770	1710	5605	6.158	6.871
May	10355	1505	3946	4.338	5.001
June	1505	220	722	0.793	0.885
July	1505	130	439	0.482	0.555
August	2975	80	263	0.289	0.333
September	1005	100	225	0.247	0.276
October	1505	130	357	0.389	0.449
November	4090	250	582	0.639	0.713
December	14100	935	3319	3.649	4.207
1894					
January	8470	1080	2443	2.685	3.096
February	4615	1325	2360	2.592	2.699
March	8730	1415	3187	3.509	4.045
April	8990	1415	2954	3.225	3.599
May	36780	660	4806	5.281	6.088
June	6780	490	1954	2.146	2.395
July	440	100	217	0.238	0.274
August	280	50	114	0.129	0.149
September	8990	30	1365	1.541	1.776
October	935	250	438	0.481	0.554
November	2160	545	1378	1.514	1.689
December	3590	660	1656	1.815	2.093
The year	36780	30	1906	2.096	28.457
1895					
April	21350	1005	4821	5.292	5.904
May	1160	490	777	0.854	0.985
June	3435	250	804	0.884	0.986
July	1820	545	1009	1.109	1.278
August	2415	250	572	0.629	0.725
September	1240	80	335	0.368	0.411
October	190	80	106	0.116	0.134
1901					
November	11480	165	1604	1.762	1.966
December	20420	1240	3492	3.836	4.423
1902					
January	5730	1005	2332	2.564	2.955
February	10900	1605	2843	3.124	3.253
March	32700	1240	5858	6.435	7.419
April	14700	935	3120	3.427	3.697
May	3280	660	1431	1.572	1.754
June	13220	545	1364	1.499	1.672
July	19200	1710	5082	5.592	6.447
August	3435	250	949	1.042	1.201
September	1080	165	317	0.349	0.389
October	1505	360	705	0.774	0.892
November	1415	250	472	0.519	0.579
December	9255	360	2752	3.017	3.478
The year	32700	165	2269	2.493	33.736

Estimated Monthly Discharge of Clarion River at Clarion, Pa.—(Continued.)

Month	Discharge in second feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1903					
January	12930	1415	3749	4.119	4.748
February	22900	2040	8410	9.235	9.617
March	23860	2415	6919	7.606	8.769
April	6560	935	2798	3.913	4.365
May	1325	280	570	0.626	0.722
June	5930	280	1179	1.296	1.446
July	6780	440	1542	1.696	1.955
August	2415	320	842	0.926	1.068
September	4090	400	1191	1.308	1.459
October	6780	280	1326	1.458	1.681
November	15300	220	2309	2.536	2.829
December	2975	660	1833	2.013	2.320
The year	23860	220	2722	3.061	40.979
1904					
January	27750	660	3343	3.666	4.226
February	19200	1080	3066	3.371	3.510
March	26100	1415	7846	8.632	9.951
April	25780	1415	4986	5.481	6.115
May	10900	1005	3132	3.446	3.973
June	3280	1080	1709	1.881	2.099
July	13510	720	2764	3.043	3.508
August	2285	250	764	0.839	0.967
September	1160	145	396	0.436	0.486
October	2160	320	852	0.936	1.044
November	600	130	259	0.285	0.318
11 months	27750	130	2647	2.910	36.197
1905					
January	13800	1710	5638	6.199	7.146
February	3590	190	1275	1.398	1.456
March	39300	190	7955	8.745	10.082
April	4615	660	1942	2.129	2.375
May	2550	860	1482	1.625	1.874
June	4090	490	1727	1.898	2.047
July	7475	545	1962	2.162	2.412
August	2550	545	1196	1.317	1.518
September	9255	320	1478	1.624	1.811
October	8215	490	2568	2.826	3.257
November	9255	1005	1973	2.170	2.421
December	16500	1240	4082	4.492	5.178
The year	39300	190	2783	3.049	31.577
1906					
January	10900	1930	3630	3.987	4.596
February	4090	1710	2595	2.851	2.969
March	9520	935	2302	2.528	2.914
April	12930	1710	4241	4.652	5.190
May	2285	1080	1664	1.831	2.111
June	1605	360	949	1.042	1.162
July	660	110	232	0.255	0.294
August	1415	90	456	0.501	0.578
September	1415	280	545	0.598	0.667
October	2285	360	1262	1.389	1.600
November	3590	545	1455	1.599	1.784
December	10900	1240	2976	3.271	3.771
The year	12930	90	1859	2.042	27.636

Estimated Monthly Discharge of Clarion River at Clarion, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
January	10900	2285	4855	5.332	6.148
February	13800	2160	6612	7.273	7.573
March	15300	2285	5644	6.200	7.148
April	9790	860	2427	2.667	2.976
May	3280	935	2068	2.275	2.622
June	3280	1080	1877	2.062	2.300
July	2550	400	1172	1.288	1.485
August	440	100	162	0.178	0.205
September	2285	100	883	0.971	1.083
October	3590	660	1598	1.761	2.030
November	5540	660	1809	1.987	2.216
December	13800	545	2825	3.108	3.583
The year	15300	100	2661	2.925	39.367
1908					
January	8215	2040	3429	3.768	4.344
February	22900	2415	4945	5.434	5.860
March	21350	3590	8624	9.481	10.930
April	7715	2415	3933	4.315	4.814
May	10900	1930	4807	5.283	6.090
June	5165	860	1905	2.091	2.333
July	16570	790	2070	2.204	2.540
August	1240	280	675	7.410	0.854
September	250	90	133	0.146	0.163
October	80	50	67	0.074	0.085
November	165	60	119	0.131	0.146
December	3125	90	839	0.922	1.063
The year	22900	50	2629	3.439	39.222
1909					
January	9790	1820	4221	4.638	5.347
February	16800	2975	6648	7.290	7.591
March	7010	1930	3923	4.311	4.970
April	31600	1415	4446	4.885	5.450
May	24215	280	5251	5.770	6.537
June	660	250	423	0.465	0.519
July	2550	220	327	0.359	0.414
August	220	125	175	0.192	0.221
September	145	125	131	0.144	0.161
October	220	100	147	0.161	0.186
November	130	100	105	0.115	0.128
December	130	100	117	0.129	0.148
The year	31600	100	2159	2.372	31.672
1910					
January	26100	660	2730	3.000	3.459
February	34250	660	2665	2.928	3.049
March	22280	2040	7329	8.054	9.285
April	7475	280	2139	2.351	2.623
May	2550	790	1453	1.597	1.841
June	2285	320	903	0.992	1.107
July	545	280	323	0.355	0.409
August	250	110	149	0.164	0.189
September	600	110	250	0.275	0.307
October	600	110	225	0.247	0.285
November	2550	110	810	0.891	0.994
December	10900	660	1501	1.651	1.903
The year	34250	110	1706	1.875	25.451

Estimated Monthly Discharge of Clarion River at Clarion, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1911					
January	18600	1005	5247	5.765	6.542
February	6340	1005	2388	2.621	2.729
March	6130	720	2106	2.314	2.668
April	7240	1820	3839	4.219	4.707
May	2690	490	1007	1.107	1.276
June	3435	280	612	0.675	0.753
July	400	220	267	0.293	0.338
August	20730	130	1876	2.061	2.376
September	13800	860	4094	4.499	5.020

FRENCH CREEK AT CARLTON, PA.

This station, situated on the steel highway bridge at Carlton, Mercer County, Pa., 13 miles above Franklin, was established April 29, 1908, by K. C. Grant, for the Water Supply Commission of Pennsylvania.

A staff gage is bolted to the downstream side of the middle pier. The zero of the gage is 17.58 feet below the right-hand downstream corner of the center pier coping.

Measurements are taken from the downstream side of the bridge at ordinary stages, and by wading at low stages. The initial point for soundings is the end of upper angle of downstream handrail at right bank.

The channel above the station curves gradually to the left. An old dam is situated about 800 feet upstream. A shoal just above the bridge divides the river at low stages and causes cross currents. The channel below the station curves gradually to the left. The bed of the river is of sand and gravel and is fairly permanent.

The left bank is low, about 8 feet below floor of bridge, and at high water the creek is widened to an extent of about 400 feet. The right bank is high and does not overflow. The greatest range of gage heights is about 16 feet.

The gage is read twice daily by E. E. Dean.

The drainage area above the station is 1,070 square miles.

Discharge Measurements of French Creek at Carlton, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1908			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Mar.	19	K. C. Grant	265	1592	4.50	6.74	7170
May	14	do	189	385	2.61	2.03	1006
Aug.	24	G. C. Stevens	132	75	1.33	0.12	100
Sept.	27	Gannett and Ryder	110	82	0.78	-0.04	64
1909							
Feb.	25	J. D. Stevenson	263	2112	5.32	8.76	11232
May	1	F. E. Langenheim	255	2690	7.45	11.10	20043
May	2	do	255	2791	7.50	11.48	20959
May	3	do	255	2466	6.34	10.18	15693
May	3	do	255	2329	5.94	9.73	13840
May	3	do	255	2228	5.92	9.25	13214
May	4	do	255	1802	5.09	7.63	9176
May	4	do	255	1665	5.04	7.08	8391
May	4	do	244	1524	4.81	6.60	7338
May	5	do	244	1276	4.35	5.53	5551
May	5	do	244	1184	4.36	5.17	5163
July	24	K. C. Grant	...	....	....	0.37	213

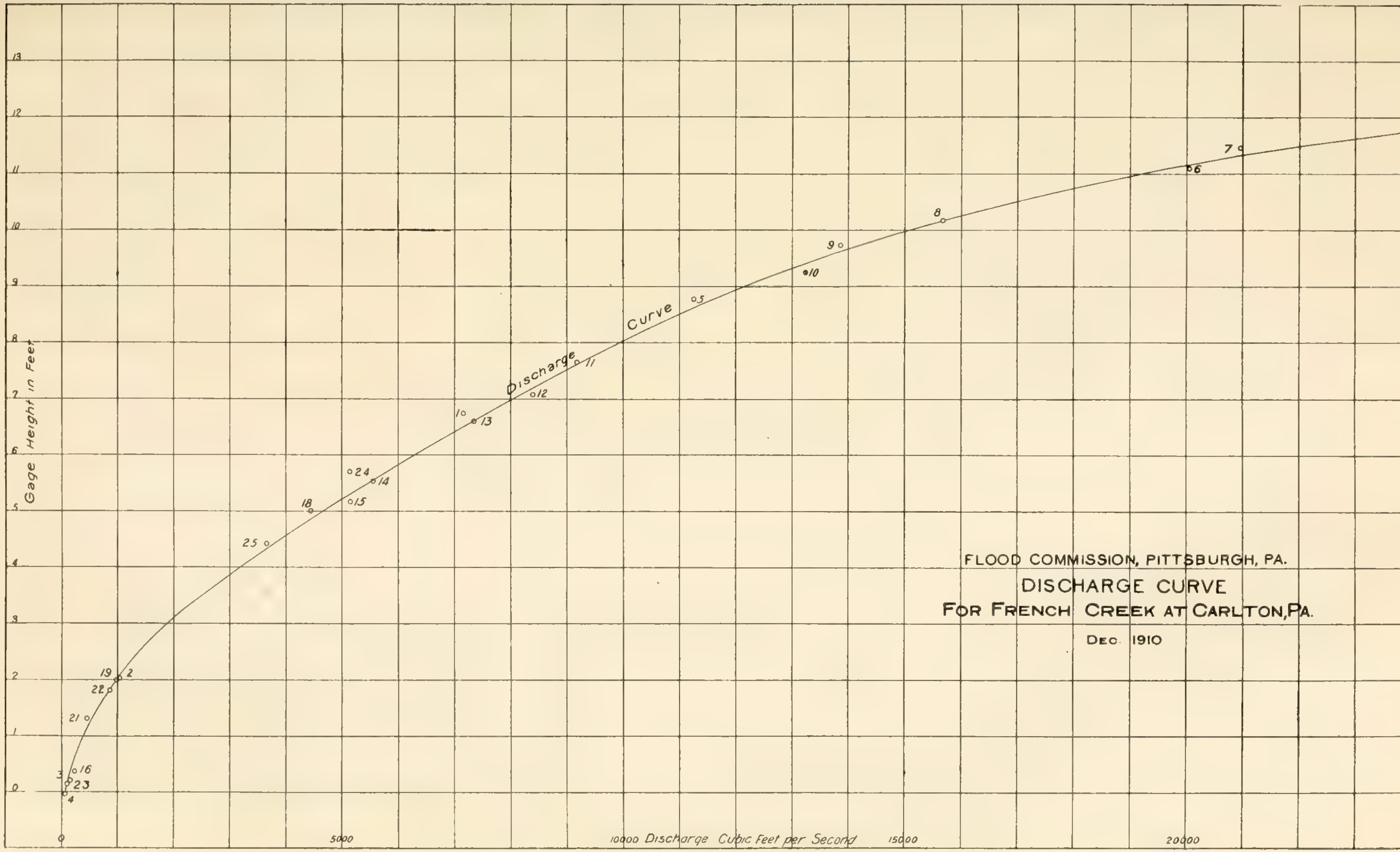
Discharge Measurements of French Creek at Carlton, Pa.—(Continued.)

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Mar.	1	H. P. Drake	265	2208	4.63	9.45	9711
Mar.	12	do	265	1024	4.30	5.00	4453
Apr.	8	do	245	393	2.48	2.00	977
May	5	do	265	1423	3.96	6.60	5655
May	31	do	241	231	2.00	1.30	462
June	12	do	244	357	2.52	1.80	894
Aug.	11	do	235	94	1.63	0.29	153
Nov.	3	do	240	1190	4.31	5.70	5129
Nov.	17	do	218	908	4.03	4.42	3659

Rating Table for French Creek at Carlton, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.00	70	2.50	1375	5.00	4680	7.50	8975	10.00	15090
.10	90	.60	1460	.10	4830	.60	9160	.10	15450
.20	110	.70	1550	.20	4990	.70	9350	.20	15830
.30	137	.80	1650	.30	5150	.80	9540	.30	16220
.40	165	.90	1755	.40	5310	.90	9730	.40	16620
.50	197	3.00	1865	.50	5470	8.00	9925	.50	17030
.60	230	.10	1980	.60	5635	.10	10125	.60	17450
.70	263	.20	2105	.70	5800	.20	10325	.70	17880
.80	300	.30	2230	.80	5965	.30	10525	.80	18320
.90	342	.40	2360	.90	6130	.40	10740	.90	18770
1.00	385	.50	2500	6.00	6295	.50	10960	11.00	19230
.10	432	.60	2640	.10	6460	.60	11195	.10	19710
.20	480	.70	2780	.20	6630	.70	11430	.20	20200
.30	535	.80	2920	.30	6800	.80	11665	.30	20700
.40	595	.90	3060	.40	6975	.90	11900	.40	21200
.50	655	4.00	3200	.50	7150	9.00	12135	.50	21710
.60	715	.10	3345	.60	7330	.10	12380	.60	22240
.70	780	.20	3490	.70	7510	.20	12640	.70	22800
.80	845	.30	3635	.80	7690	.30	12920	.80	23370
.90	910	.40	3780	.90	7870	.40	13200	.90	23950
2.00	980	.50	3930	7.00	8050	.50	13490	12.00	24530
.10	1050	.60	4080	.10	8235	.60	13795	....	....
.20	1125	.70	4230	.20	8420	.70	14100	....	....
.30	1205	.80	4380	.30	8605	.80	14420	....	....
.40	1290	.90	4530	.40	8790	.90	14750	....	....

PLATE 100



FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR FRENCH CREEK AT CARLTON, PA.
DEC. 1910
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
0
5000
10000
15000
20000
0
1
2
3
4
5
6
7
8
9
10
11
12
13

Daily Gage Heights and Discharges of French Creek at Carlton, Pa., for 1908.

Day	May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.25	1165	3.75	2850	1.70	780	0.60	230	0.00	70	–0.05	60	0.05	80	0.20	110
2	3.95	3130	3.35	2295	1.75	810	0.50	197	0.00	70	0.00	70	0.00	70	0.20	110
3	5.55	5550	2.65	1505	1.65	750	0.50	197	0.00	70	0.00	70	0.00	70	0.20	110
4	5.65	5720	2.25	1165	1.50	655	0.40	165	0.00	70	0.00	70	0.00	70	0.20	110
5	5.10	4830	1.85	880	1.75	810	0.55	214	0.00	70	–0.02	66	0.00	70	0.20	110
6	4.00	3200	1.60	715	1.45	625	1.00	385	0.00	70	–0.08	54	0.00	70	0.20	110
7	3.15	2040	1.25	510	1.25	510	1.15	456	0.00	70	–0.10	50	0.00	70	0.30	135
8	4.45	3855	1.20	480	1.40	595	1.00	385	0.00	70	–0.05	60	0.00	70	0.30	135
9	4.55	4005	1.15	456	1.25	510	0.95	364	0.00	70	–0.05	60	0.00	70	0.30	135
10	3.70	2780	1.10	432	1.05	408	0.80	300	0.00	70	–0.05	60	0.00	70	0.30	135
11	3.30	2230	1.00	385	0.80	300	0.75	282	0.00	70	–0.10	50	0.10	90	0.45	181
12	2.60	1460	0.90	342	0.65	246	0.70	263	0.00	70	–0.05	60	0.20	110	0.65	246
13	2.25	1165	0.80	300	0.65	246	0.65	246	0.00	70	–0.05	60	0.20	110	0.75	282
14	2.00	980	0.75	282	0.70	263	0.55	214	0.00	70	0.00	70	0.20	110	0.80	300
15	2.75	1600	1.40	595	0.70	263	0.50	197	–0.05	60	0.00	70	0.20	110	0.85	321
16	4.60	4080	2.15	1090	0.70	263	0.50	197	–0.05	60	–0.05	60	0.20	110	0.95	364
17	5.05	4755	1.70	780	0.70	263	0.40	165	–0.05	60	–0.05	60	0.20	110	1.25	510
18	4.25	3560	1.25	510	0.65	246	0.40	165	–0.05	60	–0.05	60	0.20	110	2.85	1700
19	3.50	2500	0.95	364	0.68	256	0.30	135	–0.05	60	–0.05	60	0.20	110	4.35	3710
20	3.95	3130	0.80	300	0.70	263	0.20	110	–0.10	50	–0.02	66	0.20	110	3.80	2920
21	3.95	3130	0.75	282	0.90	342	0.20	110	–0.10	50	0.00	70	0.20	110	2.60	1460
22	3.30	2230	0.75	282	0.90	342	0.10	90	–0.10	50	0.00	70	0.20	110	2.10	1055
23	2.95	1810	1.15	456	0.85	321	0.10	90	–0.10	50	0.00	70	0.25	122	1.45	625
24	2.50	1375	1.05	408	0.80	300	0.10	90	–0.10	50	0.00	70	0.30	135	1.20	480
25	2.10	1050	1.65	750	1.10	432	0.00	70	–0.10	50	0.00	70	0.25	122	1.55	685
26	1.85	880	1.35	565	1.20	480	0.00	70	–0.10	50	0.00	70	0.20	110	1.60	715
27	5.00	4680	1.05	408	0.95	364	0.00	70	–0.10	50	0.10	90	0.20	110	1.50	655
28	4.40	3780	0.85	321	0.80	300	0.00	70	–0.10	50	0.10	90	0.20	110	1.50	655
29	3.20	2105	0.80	300	0.70	263	0.00	70	–0.10	50	0.10	90	0.20	110	1.55	685
30	4.05	3270	1.05	408	0.70	263	0.00	70	–0.05	60	0.10	90	0.20	110	1.85	880
31	3.50	2500	....	...	0.70	263	0.00	70	....	..	0.10	90	....	...	3.35	2295

Daily Gage Heights and Discharges of French Creek at Carlton, Pa., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec. ft.*	*Feet*	*Sec.-ft.*
1	3.65	2710	1.75	812	4.15	3418	3.85	2990	10.90	18770	1.50	655
2	2.70	1550	1.45	625	3.65	2710	3.45	2430	c11.40	21200	1.45	625
3	2.30	1205	1.45	625	3.90	3060	3.20	2105	9.85	14585	1.40	595
4	2.80	1650	1.55	685	4.30	3635	3.25	2168	7.15	8328	1.40	595
5	5.25	5070	2.25	1165	3.75	2850	3.20	2105	5.35	5230	3.00	1865
6	6.85	7780	4.45	3855	3.50	2500	3.15	2042	4.80	4380	3.75	2850
7	6.65	7420	5.55	5552	4.10	3345	3.85	2990	4.05	3272	3.05	1923
8	4.70	4320	4.80	4380	4.55	4005	4.00	3200	3.50	2500	2.60	1460
9	3.15	2042	3.65	2710	5.00	4680	3.60	2640	3.00	1865	2.00	980
10	2.85	1702	3.85	2990	6.80	7690	3.10	1980	2.85	1702	2.10	1050
11	2.65	1505	4.00	3200	7.35	8698	2.85	1702	3.80	2920	2.70	1550
12	2.35	1248	3.15	2042	7.05	8140	2.85	1702	4.50	3930	2.85	1702
13	2.05	1015	3.75	2850	5.15	4910	3.30	2230	3.85	2990	2.10	1050
14	2.20	1125	4.90	4530	4.20	3490	4.55	4005	3.20	2105	1.75	812
15	2.80	1650	7.50	8975	3.75	2850	4.85	4455	2.90	1755	1.60	715
16	3.35	2295	8.05	10025	3.30	2230	4.05	3272	4.45	3855	1.60	715
17	2.75	1600	7.30	8605	3.00	1865	3.35	2295	4.60	4080	1.50	655
18	2.35	1248	5.15	4910	2.90	1755	2.95	1810	4.10	3345	1.60	715
19	2.25	1165	4.55	4005	2.80	1650	2.55	1418	3.10	1980	1.50	655
20	2.05	1015	5.45	5390	3.20	2105	2.25	1165	2.60	1460	1.40	595
21	2.15	1088	5.75	5882	3.05	1923	2.20	1125	2.30	1205	1.30	535
22	3.05	1923	5.15	4910	2.75	1600	3.10	1980	1.95	945	1.25	508
23	6.20	6630	5.60	5635	2.50	1375	3.85	2990	1.80	845	1.20	480
24	7.25	8513	7.85	9635	2.20	1125	3.30	2230	1.75	812	4.05	3272
25	6.90	7870	8.75	11548	3.90	3060	2.60	1460	1.70	780	4.20	3490
26	5.20	4990	a8.95	12018	5.10	4830	2.25	1165	1.70	780	3.35	2295
27	3.90	3060	7.35	8698	5.10	4830	2.05	1015	1.60	715	3.20	2105
28	3.25	2168	5.35	5230	5.00	4680	1.95	945	1.70	780	3.80	2920
29	2.70	1550	....	....	5.05	4755	2.30	1205	1.70	780	3.25	2168
30	2.35	1248	....	....	4.55	4005	b9.00	12135	1.60	715	2.55	1418
31	2.05	1015	....	....	4.10	3345	....	....	1.55	685	....	....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.90	910	0.34	147	0.45	181	0.24	120	0.40	165	1.22	491
2	1.55	685	0.33	144	0.42	171	0.38	159	0.37	156	1.09	427
3	1.35	565	0.33	144	0.38	159	0.88	334	0.35	150	0.98	376
4	1.20	480	0.32	141	0.37	156	0.88	334	0.35	150	0.89	338
5	1.15	456	0.30	135	0.36	153	0.58	223	0.34	147	0.79	296
6	1.05	408	0.30	135	0.34	147	0.48	191	0.34	147	0.70	263
7	1.00	385	0.30	135	0.32	141	0.39	162	0.33	144	0.70	263
8	1.00	385	0.28	130	0.30	135	0.34	147	0.33	144	0.98	376
9	1.00	385	0.28	130	0.29	133	0.29	133	0.45	181	1.90	910
10	1.00	385	0.28	130	0.28	130	0.26	125	0.60	230	2.34	1239
11	0.95	364	0.28	130	0.28	130	0.24	120	0.76	285	2.34	1239
12	0.90	342	0.28	130	0.28	130	0.27	128	0.85	321	2.34	1239
13	1.05	408	0.28	130	0.28	130	0.28	130	0.60	230	2.33	1230
14	1.20	480	0.28	130	0.28	130	0.28	130	0.51	200	2.50	1375
15	1.30	535	0.28	130	0.28	130	0.28	130	0.44	178	3.10	1980
16	1.40	595	0.29	133	0.28	130	0.28	130	0.41	168	3.65	2710
17	1.45	625	0.80	300	0.27	128	0.28	130	0.59	227	3.70	2780
18	1.15	456	1.02	394	0.26	125	0.28	130	1.24	502	3.15	2042
19	0.95	364	0.89	338	0.24	120	0.31	138	1.87	890	3.10	1980
20	0.80	300	0.58	223	0.22	115	0.34	147	1.81	852	3.10	1980
21	*0.70	263	0.40	165	0.22	115	0.30	135	1.84	871	3.25	2168
22	*0.60	230	0.30	135	0.22	115	0.33	144	2.90	1755	3.20	2105
23	*0.50	197	0.30	135	0.22	115	0.37	156	3.94	3116	3.05	1923
24	0.38	159	0.28	130	0.23	118	0.68	256	4.00	3200	3.00	1865
25	0.44	178	0.28	130	0.28	130	0.94	359	3.40	2360	3.00	1865
26	0.44	178	0.28	130	0.28	130	1.15	456	2.50	1375	3.00	1865
27	0.42	171	0.34	147	0.27	128	1.07	418	1.94	938	3.05	1923
28	0.40	165	0.50	197	0.26	125	0.94	359	1.58	703	3.30	2230
29	0.34	147	0.46	184	0.25	123	0.87	123	1.38	583	3.65	2710
30	0.33	144	0.42	171	0.24	120	0.76	285	1.32	547	3.85	2990
31	0.34	147	0.44	178	....	...	0.56	217	....	...	4.00	3200

a. Max. 8 A. M., 9.0 = 12135 sec.-ft.   c. Max. 8 A. M., 11.60 = 22240 sec.-ft.
b. Max. 5 P. M., 9.4 = 13200 sec.-ft.   *Estimated.
Note. Readings July 1-23 not reliable; water receded from gage.

Daily Gage Heights and Discharges of French Creek at Carlton, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.00	3200	4.18	3461	9.78	14356	1.69	774	2.45	1332	1.45	625	0.30	137	0.30	137	0.20	110	0.29	134	3.60	2640	4.15	3417
2	4.20	3490	4.12	3374	10.80	18320	1.58	703	4.00	3200	2.75	1600	0.30	137	0.26	126	0.20	110	0.28	132	4.50	3930	3.95	3130
3	4.70	4230	4.05	3272	c11.80	23370	1.48	643	5.60	5635	3.95	3130	0.30	137	0.22	115	0.20	110	0.26	126	5.63	5685	3.80	2920
4	5.28	5118	4.30	3635	11.90	23950	1.40	595	6.80	7690	4.50	3930	0.30	137	0.21	113	0.65	213	0.24	121	5.40	5310	3.78	2892
5	5.35	5230	4.38	3751	11.35	20950	2.20	1125	6.30	6800	3.58	2612	0.30	137	0.20	110	0.78	293	0.22	117	3.65	2710	3.66	2712
6	5.42	5342	4.24	3548	11.05	19470	2.16	1095	4.60	4080	2.90	1755	0.30	137	0.20	110	0.92	400	0.38	159	3.05	1927	3.46	2438
7	5.85	6048	4.12	3374	11.00	19230	2.08	1036	3.55	2570	2.50	1375	0.38	159	0.20	110	1.70	780	1.25	502	2.40	1290	3.25	2167
8	6.00	6295	2.95	1810	9.80	14420	2.02	994	2.95	1810	2.40	1290	0.38	159	0.20	110	1.85	877	1.95	942	2.40	1290	3.35	2295
9	6.00	6295	2.78	1630	8.50	10960	1.98	966	2.75	1600	2.19	1118	0.29	133	0.20	110	1.35	565	1.55	685	2.20	1125	2.90	1755
10	5.92	6163	2.72	1570	7.30	8605	1.82	858	2.44	1324	1.92	924	0.25	123	0.20	110	1.05	407	1.25	502	3.45	2435	2.55	2570
11	5.52	5503	2.68	1532	6.20	6630	1.68	767	2.05	1015	1.78	832	0.25	123	0.30	137	0.88	334	0.85	321	6.25	6715	2.20	1125
12	5.20	4990	2.82	1671	4.95	4605	1.58	703	1.86	884	1.80	845	0.25	123	0.50	197	0.76	285	0.68	257	7.55	9067	2.00	980
13	4.92	4560	3.55	2570	4.70	4230	1.45	625	1.72	793	2.24	1157	0.42	171	0.42	171	0.62	236	0.52	203	7.90	9730	2.00	980
14	4.45	3855	3.05	1923	4.36	3722	1.28	524	1.55	685	1.90	910	0.70	263	0.32	143	0.47	189	0.38	159	6.20	6630	2.00	980
15	4.10	3345	2.60	1460	3.95	3130	1.18	470	1.36	571	1.65	748	0.70	263	0.28	132	0.38	159	0.34	144	5.40	5310	2.00	980
16	4.10	3345	2.75	1600	3.80	2920	1.10	432	1.29	530	1.35	565	0.68	256	0.20	110	0.31	140	0.30	137	4.75	4305	2.00	980
17	5.05	4755	4.70	4230	3.80	2920	1.18	470	1.26	513	1.20	480	0.55	214	0.20	110	0.30	137	0.30	137	4.36	3722	2.00	980
18	8.95	12018	5.40	5310	3.74	2836	1.22	491	1.22	491	0.96	368	0.42	171	0.20	110	0.30	137	0.28	132	4.16	3432	2.15	1085
19	7.95	9828	5.30	5150	3.64	2696	1.32	547	1.19	475	0.88	334	0.34	144	0.20	110	0.30	137	0.27	129	3.96	3144	2.34	1237
20	9.52	13551	4.95	4605	4.00	3200	1.65	748	1.14	451	0.80	300	0.26	126	0.20	110	0.28	132	0.27	129	3.80	2920	2.44	1324
21	a8.88	11853	4.55	4005	5.08	4800	1.95	945	1.08	423	0.78	293	0.25	123	0.20	110	0.26	126	0.27	129	3.68	2752	2.57	1435
22	7.40	8790	4.50	3930	5.28	5118	2.05	1015	1.14	451	0.76	285	0.25	123	0.20	110	0.24	121	0.27	129	3.64	2696	2.76	1604
23	6.10	6460	4.55	4005	4.65	4155	2.02	994	1.10	432	0.66	250	0.24	121	0.20	110	0.22	117	0.35	151	3.52	2528	2.95	1810
24	6.10	6460	4.42	3810	4.14	3403	1.85	878	1.10	432	0.45	181	0.22	117	0.20	110	0.22	117	0.55	213	4.50	3930	3.40	2360
25	5.02	4710	4.26	3577	3.78	2892	3.85	2990	1.10	432	0.30	135	0.22	117	0.20	110	0.36	154	0.99	381	6.65	7420	3.89	3046
26	4.72	4260	3.95	3130	3.42	2388	5.40	5310	1.10	432	0.30	135	0.36	154	0.20	110	0.47	189	1.60	715	7.00	8050	4.15	3417
27	4.60	4080	4.20	3490	3.00	1865	4.80	4380	1.10	432	0.30	135	0.31	140	0.20	110	0.44	176	2.20	1125	6.60	7330	3.92	3088
28	4.60	4080	b7.98	9886	2.62	1478	4.00	3200	1.10	432	0.30	135	0.28	132	0.20	110	0.36	154	2.05	1015	5.55	5552	3.95	3130
29	4.59	4065	....	....	2.20	1125	3.18	2080	1.10	432	0.30	135	0.25	123	0.20	110	0.30	137	2.65	1502	5.15	4910	5.65	5715
30	4.51	3945	....	....	1.96	952	2.68	1532	1.10	432	0.30	135	0.30	137	0.20	110	0.30	137	3.30	2230	4.55	4105	6.95	7960
31	4.20	3490	....	....	1.80	845	....	....	1.10	432	....	...	0.34	144	0.20	110	....	...	3.34	2282	....	....	7.15	8325

a. Max. 8 A. M. 9.75 = 14260 sec.-ft. b. Max. 5 P. M. 8.55 = 11078 sec.-ft. c. Max. 5 P. M. 12.0 = 24530 sec.-ft.

Daily Gage Heights and Discharges of French Creek at Carlton, Pa., for 1911.

Day	January		February		March		April		May		June		July		August		September		October	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	7.00	8050	5.20	4990	3.20	2105	3.95	3130	2.00	980	0.50	197	0.66	250	0.30	137	3.30	2230	5.05	4755
2	7.15	8327	4.30	3635	2.90	1755	3.65	2710	3.80	2920	0.50	197	0.55	213	0.30	137	2.48	1358	6.45	7062
3	8.45	10850	3.68	2752	2.75	1595	3.30	2230	3.65	2710	0.50	197	0.50	197	0.30	137	1.71	786	5.90	6130
4	8.05	10025	3.55	2570	2.40	1290	3.15	2042	3.10	1980	0.50	197	0.50	197	0.30	137	1.30	535	5.00	4680
5	7.40	8790	3.35	2295	2.05	1015	5.25	5070	2.62	1477	0.57	220	0.50	197	0.30	137	0.95	364	4.65	4155
6	5.90	6130	3.20	2105	2.00	980	6.15	6545	2.30	1205	0.75	281	0.50	197	0.30	137	1.40	595	4.45	3855
7	4.85	4455	2.95	1810	2.00	980	6.20	6630	1.92	923	0.80	300	0.50	197	0.40	165	2.26	1173	4.70	4230
8	4.15	3417	2.75	1595	2.00	980	5.55	5552	1.65	745	0.80	300	0.50	197	0.38	159	2.30	1205	4.60	4080
9	4.05	3272	2.46	1341	2.00	980	4.40	3780	1.45	625	0.72	270	0.50	197	0.34	148	2.20	1125	4.05	3272
10	3.85	2990	2.28	1190	2.90	1755	3.95	3130	1.32	547	0.62	237	0.50	197	0.32	143	2.01	987	3.35	2295
11	3.75	2850	2.20	1125	4.35	3707	3.60	2640	1.30	535	0.52	204	0.48	191	0.30	137	1.65	745	2.97	1832
12	6.70	7510	2.13	1071	4.10	3345	3.25	2167	1.30	535	0.75	281	0.45	179	0.28	132	1.30	535	2.79	1640
13	8.00	9925	2.05	1015	4.40	3780	2.90	1755	1.30	535	1.25	507	0.41	168	0.26	126	1.05	409	2.68	1532
14	9.85	14585	2.40	1290	4.20	3490	2.85	1702	1.26	513	1.56	691	0.38	159	0.25	123	0.88	334	2.35	1248
15	a10.40	16620	5.80	5965	3.95	3130	2.95	1810	1.17	466	1.15	456	0.36	154	0.26	126	b5.33	5198	2.15	1088
16	9.65	13950	6.35	6887	3.45	2425	2.85	1702	1.07	420	0.90	342	0.34	148	0.36	154	7.00	8050	1.95	945
17	7.80	9540	6.25	6715	2.50	1375	2.75	1595	1.00	385	0.68	256	0.32	143	1.00	385	6.50	7150	1.90	910
18	5.60	5635	7.50	8975	2.70	1550	2.57	1434	1.00	385	0.56	217	0.31	140	1.00	385	4.60	4080	6.30	6800
19	4.25	3562	8.05	10025	3.05	1927	2.50	1375	1.00	385	0.50	197	0.30	137	0.85	321	3.60	2640	6.50	7150
20	3.67	2738	7.80	9540	3.20	2105	3.70	2780	1.00	385	0.50	197	0.30	137	0.75	281	2.94	1799	5.68	5767
21	3.50	2500	6.00	6295	3.75	2850	4.95	4605	0.99	381	0.50	197	0.30	137	0.55	213	2.64	1496	4.45	3855
22	3.45	2425	4.20	3490	4.00	3200	4.10	3345	0.94	359	0.50	197	0.30	137	0.36	154	2.33	1230	3.71	2794
23	3.25	2167	3.55	2570	4.25	3562	3.70	2780	0.88	334	0.50	197	0.30	137	0.25	123	2.02	994	3.36	2308
24	3.00	1865	3.35	2295	4.30	3635	3.30	2230	0.79	296	0.50	197	0.30	137	0.25	123	1.82	858	3.25	2168
25	2.65	1502	3.15	2042	3.45	2425	2.85	1702	0.70	263	0.50	197	0.30	137	0.34	148	1.60	715	3.05	1922
26	2.50	1375	3.25	2167	3.15	2042	2.65	1502	0.61	233	0.67	253	0.30	137	0.44	176	1.25	508	2.74	1590
27	3.30	2230	4.50	3930	3.75	2850	2.30	1205	0.57	220	1.60	715	0.30	137	0.70	263	1.40	595	2.50	1375
28	8.20	10325	3.95	3130	4.85	4455	1.95	942	0.53	207	1.85	877	0.30	137	1.70	780	1.90	910	2.38	1273
29	9.85	14585	....	....	4.80	4380	1.80	845	0.50	197	1.30	535	0.30	137	5.20	4990	3.80	2920	2.26	1173
30	9.90	14750	....	....	4.15	3417	1.92	923	0.50	197	0.94	359	0.30	137	6.10	6460	6.20	6630	2.20	1125
31	7.20	8420	....	....	4.20	3490	....	...	0.50	197	....	...	0.30	137	4.80	4380	....	....	2.35	1248

a. Max. noon, 10.55 = 17240 sec.-ft. b. Max. 6.25 P. M., 7.80 = 9540 sec.-ft.

Estimated Monthly Discharge of French Creek at Carlton, Pa.

[Drainage area, 1070 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1908					
May	5720	880	2856	2.669	3.077
June	2850	282	681	0.637	0.711
July	810	246	411	0.384	0.443
August	456	70	185	0.173	0.200
September	70	50	61	0.057	0.064
October	90	50	68	0.064	0.071
November	135	70	98	0.092	0.102
December	3710	110	707	0.661	0.762
1909					
January	8513	1015	2880	2.692	3.103
February	12135	625	5053	4.722	4.917
March	8698	1125	3584	3.350	3.862
April	13200	945	2498	2.335	2.605
May	22240	685	3848	3.595	4.145
June	3490	480	1365	1.276	1.424
July	910	144	371	0.347	0.400
August	394	130	165	0.154	0.177
September	181	115	133	0.124	0.138
October	456	120	205	0.192	0.221
November	3200	144	697	0.651	0.726
December	3200	263	1561	1.459	1.682
The year	22240	115	1864	1.741	23.400
1910					
January	14260	3200	5786	5.407	6.234
February	11078	1460	3404	3.181	3.312
March	24530	845	7727	7.221	8.325
April	5310	432	1263	1.180	1.317
May	7690	423	1523	1.423	1.671
June	3930	135	891	0.833	0.929
July	263	123	151	0.141	0.163
August	197	110	119	0.111	0.128
September	877	110	239	0.223	0.249
October	2282	117	482	0.451	0.520
November	9730	1125	4416	4.127	4.605
December	8325	980	2543	2.400	2.767
The year	24530	110	2378	2.222	30.220
1911					
January	17240	1375	6960	6.505	7.500
February	10025	1015	3672	3.432	3.574
March	4455	980	2469	2.300	2.652
April	6630	845	2662	2.488	2.776
May	2920	197	695	0.650	0.749
June	877	197	315	0.294	0.328
July	250	137	165	0.154	0.177
August	6460	123	691	0.646	0.744
September	9540	334	1938	1.811	2.020
October	7150	910	3040	2.841	3.275

SUGAR CREEK AT WYATTVILLE, PA.

This station, situated on the steel highway bridge at Wyattville, Venango County, Pa., 3 miles above the mouth of the creek, was established May 6, 1910, by H. P. Drake, for the Flood Commission.

A chain gage is attached to the bridge, the chain having a length of 12.34 feet from marker to bottom of weight. The elevation of the zero is 1,050.96. The elevation of the bench mark on the top of left abutment, downstream side of bridge, is 1,062.48.

Measurements are taken at ordinary stages from the downstream side of the bridge, and at low stages by wading at a point ¼ mile below the bridge. The initial point for soundings is the face of left abutment.

The channel is straight for a distance of about 600 feet above and 1500 feet below the station. At low water a pool is formed, owing to the flat slope of the creek bottom, which is gravelly and permanent. The right bank is high and does not overflow. The left bank overflows only at extremely high water. The greatest range of gage heights is about 12 feet.

The gage is read daily by Thos. G. Wyatt.

The drainage area above the gage is 159 square miles.

Discharge Measurements of Sugar Creek at Wyattville, Pa.

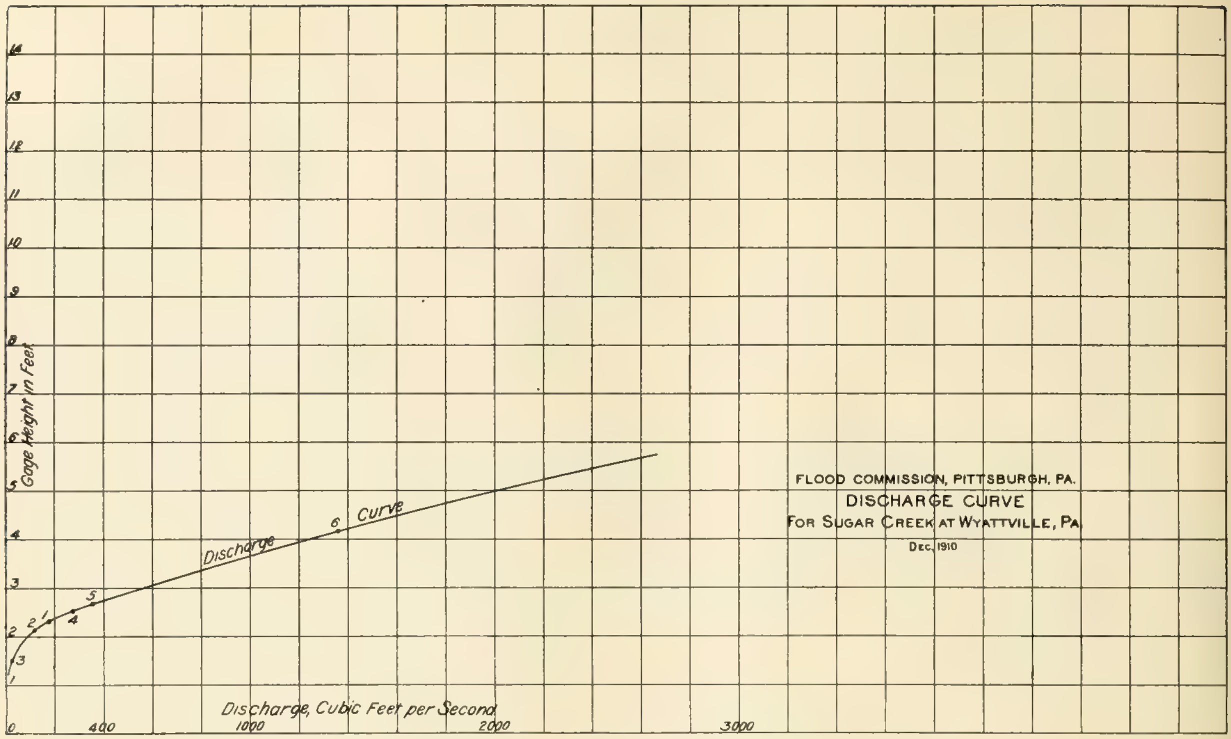
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec. ft.*
1910							
May	3a	H. P. Drake	92	363	0.52	2.30	177
June	12a	do	92	357	0.32	2.12	119
Aug.	11a	do	32	22	1.18	1.50	26
Nov.	3	do	92	390	0.70	2.51	273
Nov.	16	do	92	411	0.87	2.67	357
1911							
Jan.	2	do	92	532	2.56	4.16	1360
June	22a	do	30	18	1.06	1.32	19

a. Wading measurement.

Rating Table for Sugar Creek at Wyattville, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.00	10	1.90	71	2.80	435	3.70	1030	4.60	1700
.10	11	2.00	90	.90	495	.80	1100	.70	1780
.20	14	.10	110	3.00	557	.90	1170	.80	1860
.30	17	.20	140	.10	620	4.00	1245	.90	1940
.40	20	.30	177	.20	685	.10	1320	5.00	2020
.50	26	.40	217	.30	752	.20	1395	...	....
.60	33	.50	263	.40	820	.30	1470	...	....
.70	41	.60	315	.50	890	.40	1545	...	....
.80	55	.70	375	.60	960	.50	1620	...	....

PLATE 101



Daily Gage Heights and Discharges of Sugar Creek at Wyattville, Pa., for 1910.

Day	May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	1.80	55	1.50	26	1.50	26	1.50	26	1.50	26	2.30	177	2.80	435
2	....	....	1.90	71	1.50	26	1.50	26	1.60	33	1.50	26	2.30	177	2.70	375
3	....	....	3.00	557	1.50	26	1.50	26	1.60	33	1.50	26	2.60	315	2.70	375
4	....	....	2.60	315	1.50	26	1.50	26	1.70	41	1.50	26	2.40	217	2.60	315
5	....	....	2.40	217	1.50	26	1.50	26	1.60	33	1.60	33	2.40	217	2.60	315
6	....	....	2.10	110	1.80	55	1.50	26	1.60	33	1.90	71	2.30	177	2.50	263
7	2.10	110	1.90	71	1.70	41	1.50	26	1.60	33	2.20	140	2.20	140	2.40	217
8	2.00	90	1.90	71	1.70	41	1.50	26	1.50	26	2.10	110	2.10	110	2.30	177
9	2.00	90	1.90	71	1.70	41	1.50	26	1.50	26	2.00	90	2.10	110	2.20	140
10	1.90	71	1.80	55	1.60	33	1.60	33	1.50	26	1.90	71	2.10	110	2.30	177
11	1.80	55	1.90	71	1.60	33	1.50	26	1.60	33	1.90	71	2.80	435	2.30	177
12	1.80	55	2.10	110	1.60	33	1.50	26	1.60	33	1.80	55	2.80	435	2.40	217
13	1.70	41	2.00	90	1.70	41	1.50	26	1.60	33	1.90	71	2.70	375	2.50	263
14	1.70	41	1.90	71	1.70	41	1.50	26	1.60	33	1.80	55	2.70	375	2.50	263
15	1.70	41	1.80	55	1.70	41	1.50	26	1.60	33	1.80	55	2.70	375	2.40	217
16	1.60	33	1.90	71	1.60	33	1.50	26	1.60	33	1.80	55	2.60	315	2.30	177
17	1.60	33	1.80	55	1.90	71	1.50	26	1.50	26	1.80	55	2.60	315	2.30	177
18	1.80	55	1.80	55	1.70	41	1.50	26	1.50	26	1.80	55	2.60	315	2.40	217
19	1.80	55	1.70	41	1.60	33	1.50	26	1.50	26	1.80	55	2.60	315	2.50	263
20	1.70	41	1.70	41	1.60	33	1.50	26	1.50	26	1.70	33	2.50	263	2.50	263
21	1.70	41	1.70	41	1.60	33	1.40	20	1.40	20	1.70	33	2.60	315	2.40	217
22	1.70	41	1.60	33	1.60	33	1.40	20	1.40	20	2.00	90	2.60	315	2.30	177
23	1.70	41	1.60	33	1.70	41	1.40	20	1.40	20	1.90	71	2.80	435	2.40	217
24	1.70	41	1.60	33	1.60	33	1.40	20	1.60	33	1.90	71	3.40	820	3.30	752
25	1.80	55	1.60	33	1.60	33	1.40	20	1.90	71	1.80	55	3.90	1170	2.50	263
26	1.70	41	1.60	33	1.60	33	1.50	26	1.70	41	2.10	110	3.70	1030	2.70	375
27	1.70	41	1.50	26	1.60	33	1.60	33	1.70	41	2.00	90	3.20	685	2.60	315
28	1.60	33	1.50	26	1.60	33	1.60	33	1.60	33	2.10	110	2.90	495	2.80	435
29	1.60	33	1.50	26	1.50	26	1.60	33	1.60	33	2.10	110	3.00	557	3.90	1170
30	1.70	41	1.50	26	1.70	41	1.50	26	1.50	26	2.10	110	2.90	495	4.70	1780
31	1.80	55	....	....	1.60	33	1.50	26	....	....	2.20	140	....	....	3.50	890

Daily Gage Heights and Discharges of Sugar Creek at Wyattville, Fla., for 1911.

Day	January		February		March		April		May		June		July		August		September	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.40	820	2.40	217	2.10	110	2.40	217	2.20	140	1.50	26	1.40	20	1.20	14	1.80	55
2	4.00	1245	2.40	217	2.10	110	2.30	177	2.40	217	1.50	26	1.40	20	1.20	14	1.70	41
3	4.50	1620	2.20	140	2.00	90	2.30	177	2.20	140	1.40	20	1.30	17	1.30	17	1.70	41
4	3.50	890	2.20	140	2.00	90	2.20	140	2.00	90	1.40	20	1.30	17	1.30	17	1.60	33
5	3.10	620	2.10	110	1.90	71	3.80	1100	1.90	71	1.50	26	1.30	17	1.20	14	1.50	26
6	3.10	620	2.10	110	1.90	71	3.50	890	1.80	55	1.50	26	1.20	14	1.20	14	1.50	26
7	3.10	620	2.10	110	1.80	55	3.00	557	1.80	55	1.50	26	1.30	17	1.20	14	1.40	20
8	2.90	495	2.10	110	1.80	55	2.80	435	1.80	55	1.40	20	1.30	17	1.20	14	1.40	20
9	2.90	495	2.00	90	2.10	110	2.60	315	1.70	41	1.40	20	1.30	17	1.20	14	2.80	435
10	2.90	495	2.00	90	2.30	177	2.40	217	1.70	41	1.40	20	1.30	17	1.20	14	2.10	110
11	2.80	435	2.00	90	2.30	177	2.30	177	1.70	41	1.40	20	1.30	17	1.20	14	2.10	110
12	3.40	820	1.90	71	2.30	177	2.30	177	1.70	41	1.50	26	1.40	20	1.20	14	2.00	90
13	4.40	1545	1.90	71	2.40	217	2.20	140	1.70	41	1.70	41	1.30	17	1.20	14	1.90	71
14	4.50	1620	2.40	217	2.40	217	2.20	140	1.60	33	1.60	33	1.30	17	1.20	14	1.80	55
15	5.00	2020	3.20	685	2.30	177	2.40	217	1.60	33	1.50	26	1.30	17	1.40	20	6.00	2820
16	3.30	752	3.00	557	2.10	110	2.20	140	1.60	33	1.40	20	1.30	17	1.50	26	4.80	1860
17	2.90	495	2.90	495	2.00	90	2.30	177	1.50	26	1.40	20	1.30	17	1.60	33	4.20	1395
18	2.40	217	3.50	890	2.00	90	2.20	140	1.50	26	1.40	20	1.30	17	1.50	26	3.50	890
19	2.30	177	3.00	557	2.10	110	3.00	557	1.60	33	1.30	17	1.30	17	1.50	26	3.00	557
20	2.20	140	2.80	435	2.20	140	3.20	685	1.80	55	1.10	11	1.30	17	1.40	20	2.40	217
21	2.20	140	2.60	315	2.20	140	2.60	315	1.70	41	1.00	10	1.30	17	1.30	17	2.00	90
22	2.10	110	2.50	263	2.30	177	2.40	217	1.60	33	0.90	9	1.20	14	1.30	17	1.90	71
23	2.10	110	2.30	177	2.40	217	2.60	315	1.60	33	0.90	9	1.20	14	1.20	14	1.80	55
24	2.00	90	2.20	140	2.10	110	2.60	315	1.50	26	1.30	17	1.20	14	1.40	20	1.80	55
25	1.90	71	2.20	140	2.10	110	2.50	263	1.50	26	1.30	17	1.20	14	1.60	33	1.70	41
26	1.90	71	2.30	177	2.20	140	2.20	140	1.50	26	1.50	26	1.30	17	1.50	26	1.60	33
27	2.00	90	2.50	263	2.70	375	2.00	90	1.50	26	1.70	41	1.30	17	1.40	20	1.60	33
28	4.60	1700	2.40	217	2.60	315	2.00	90	1.40	20	1.60	33	1.20	14	3.80	1100	1.80	55
29	4.10	1320	....	...	2.50	263	2.00	90	1.40	20	1.50	26	1.20	14	2.90	495	2.60	315
30	3.20	685	....	...	2.50	263	2.20	140	1.40	20	1.40	20	1.20	14	2.40	217	2.50	263
31	2.90	495	....	...	2.40	217	....	...	1.40	20	....	..	1.20	14	2.00	90	....	...

Estimated Monthly Discharge of Sugar Creek at Wyattville, Pa.

[Drainage area, 159 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
May 7–31	110	33	53	0.334	0.297
June	557	26	85	0.534	0.595
July	71	26	36	0.226	0.259
August	33	20	26	0.163	0.188
September	71	20	32	0.201	0.224
October	140	26	70	0.441	0.508
November	1170	110	386	2.425	2.705
December	1780	140	375	2.360	2.721
1911					
January	2020	71	678	4.264	4.915
February	890	71	249	1.567	1.632
March	375	55	154	0.969	1.117
April	1100	90	292	1.837	2.050
May	217	20	50	0.314	0.362
June	41	9	22	0.139	0.155
July	20	14	16	0.103	0.119
August	1100	14	77	0.484	0.558
September	2820	20	329	2.072	2.311

CUSSEWAGO CREEK AT JONES FARM, ABOVE MEADVILLE, PA.

This station, situated on the steel highway bridge near Jones farm, 4.5 miles above Meadville, Mercer County, Pa., was established May 2, 1910, by H. P. Drake, for the Flood Commission.

Originally a staff gage was attached to the right abutment, but as this was out of water at low stages, a chain gage was installed, June 6, 1910. The length of chain from marker to bottom of weight is 14.65 feet. The zero of the gage is at an elevation of 1,071.77. The elevation of the bench mark on top of upstream side of left abutment is 1,085.40.

Measurements are taken from the downstream side of the bridge. The initial point for soundings is the outer edge of left abutment. The channel bends to the left above the station and also a short distance below. Both banks are subject to overflow at a gage height of about 8 feet. The greatest range of gage heights is about 16 feet. The bed is soft and not permanent. This is not an entirely satisfactory location for a station, but no better point could be found on the creek, as the same conditions prevail throughout its whole length.

The gage is read daily by J. E. Hofius.

The drainage area above the station is 102 square miles.

Discharge Measurements of Cussewago Creek above Meadville, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
May	3	H. P. Drake	90	459	1.18	7.95	540
May	28	do	30	44	0.63	2.10	26
June	13	do	28	59	0.80	2.50	47
Aug.	12	do	23	9	0.43	0.83	4
Oct.	28	do	65	154	0.87	4.20	134
Oct.	28	do	65	160	0.97	4.34	155
Nov.	13	do	254	...	....	9.12	688
Nov.	15	do	90	430	0.97	7.53	418
Nov.	23	do	90	252	0.90	5.63	226
1911							
June	21a	do	21	14	0.54	1.01	6

a. Wading measurement.

Daily Gage Heights and Discharges of Cussewago Creek above Meadville, Pa., for 1910.

Day	May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	3.20	80	0.76	3	1.32	9	0.54	2	0.82	3	6.90	339	7.80	487
2	....	....	5.50	219	0.86	3	1.07	5	1.04	5	0.72	3	7.40	396	6.15	267
3	7.95	542	7.20	370	0.76	3	0.87	3	1.14	6	0.67	2	7.90	528	5.90	247
4	8.45	625	7.85	507	0.76	3	0.77	3	1.69	16	0.62	2	8.40	620	5.85	242
5	9.35	707	8.10	577	0.71	3	0.72	3	1.69	16	0.62	2	8.20	593	5.80	240
6	8.50	631	4.34	146	0.71	3	0.72	3	1.24	8	0.62	2	5.40	212	5.80	240
7	4.35	146	3.69	108	0.96	4	0.67	2	1.14	6	2.82	61	3.80	115	5.50	219
8	3.35	88	3.79	114	0.76	4	0.62	2	1.04	5	4.52	156	4.20	137	5.35	207
9	3.05	72	3.04	72	0.86	3	0.66	2	1.13	6	3.02	71	5.30	205	5.00	185
10	3.00	70	2.49	40	0.81	3	0.81	3	0.98	4	2.02	26	6.50	300	5.30	205
11	2.90	65	2.19	32	a0.80	3	0.81	3	0.98	4	1.61	14	8.30	608	4.40	149
12	2.50	45	2.44	42	a0.75	3	0.86	3	0.98	4	1.51	12	9.70	741	4.40	149
13	2.35	38	2.59	45	a0.70	3	0.76	3	0.88	3	1.21	7	9.40	712	4.30	143
14	2.35	38	2.28	35	a0.75	3	0.65	2	0.73	3	1.01	5	8.70	651	4.30	143
15	2.25	34	1.88	21	a0.75	3	0.65	2	0.73	3	0.91	4	7.65	444	4.35	146
16	2.25	34	1.58	14	0.79	3	0.55	2	0.68	3	0.91	4	7.10	359	4.20	137
17	2.25	34	1.48	12	0.79	3	0.55	2	0.63	2	0.86	3	6.80	329	4.10	131
18	2.25	34	1.38	10	0.74	3	0.55	2	0.63	2	0.81	3	6.70	319	4.10	131
19	2.45	42	1.28	8	0.69	2	0.55	2	0.58	2	0.81	3	6.20	272	4.05	128
20	2.35	38	1.18	7	0.69	2	0.50	2	0.58	2	0.81	3	5.90	247	4.50	155
21	2.25	34	1.07	5	0.64	2	0.50	2	0.58	2	0.81	3	5.70	233	4.80	173
22	2.25	34	1.07	5	0.59	2	0.50	2	0.53	2	1.11	6	5.50	219	4.80	173
23	2.25	34	1.02	5	0.64	2	0.50	2	0.53	2	2.06	27	5.50	219	4.80	173
24	2.95	67	0.92	4	0.68	2	0.50	2	0.53	2	2.11	29	6.90	339	4.50	155
25	2.55	47	0.87	3	0.68	2	0.50	2	0.98	4	1.91	22	8.50	631	6.90	339
26	2.60	50	0.87	3	1.83	20	0.55	2	1.42	10	3.81	115	9.80	752	7.60	430
27	2.65	52	0.87	3	1.28	8	0.55	2	1.12	6	4.71	167	9.50	721	7.70	458
28	2.35	38	0.82	3	0.93	4	0.60	2	1.12	6	4.06	129	9.10	687	7.10	359
29	2.25	34	0.82	3	0.78	3	0.65	2	0.87	3	5.40	212	7.90	528	8.00	556
30	2.25	34	0.82	3	0.78	3	0.60	2	0.87	3	6.50	300	7.60	430	9.00	678
31	2.25	34	....	..	1.98	25	0.60	2	....	..	6.55	305	....	...	10.30	810

a. Interpolated.

Daily Gage Heights and Discharges of Cussewago Creek above Meadville, Pa., for 1911.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	9.78	751	5.46	216	4.28	142	5.96	252	2.94	67	1.02	5	1.50	12	0.60	2
2	9.38	710	4.96	180	3.78	114	5.36	209	5.34	208	1.22	7	1.50	12	0.60	2
3	10.38	818	4.96	180	3.18	79	4.66	165	4.94	181	1.02	5	1.00	5	0.60	2
4	a 10.00	775	4.56	159	3.08	74	4.16	135	3.54	99	1.02	5	1.00	5	0.60	2
5	9.48	720	4.61	162	2.98	69	6.86	335	2.84	62	1.12	6	0.90	4	0.60	2
6	8.68	649	3.76	113	2.78	59	7.96	545	2.44	42	1.12	6	0.80	3	0.90	4
7	5.68	232	3.86	119	2.78	59	8.26	602	2.44	42	1.62	14	1.90	22	0.80	3
8	5.61	227	3.46	95	2.78	59	7.26	377	1.94	24	1.42	11	1.10	6	0.75	3
9	5.51	220	3.06	73	2.78	59	5.21	199	1.74	17	1.32	9	0.85	3	0.70	3
10	6.16	268	2.81	61	4.08	130	4.71	167	1.74	17	1.22	7	0.80	3	0.70	3
11	5.86	244	2.66	53	6.48	298	4.46	155	1.84	20	1.02	5	0.75	3	0.60	3
12	8.56	637	2.46	43	5.38	211	3.76	113	1.84	20	1.02	5	1.00	5	0.60	3
13	10.46	835	2.56	48	5.28	204	3.66	107	2.14	30	4.62	162	0.90	4	0.60	3
14	a 10.40	825	2.56	48	4.98	253	3.66	107	1.94	24	3.62	104	0.75	3	0.50	3
15	a 10.40	825	7.96	545	4.58	159	4.06	129	1.74	17	2.52	46	0.75	3	0.60	3
16	9.56	727	9.56	727	3.87	119	3.95	123	1.53	12	1.92	22	0.70	3	0.90	4
17	8.96	674	9.26	700	3.17	78	3.25	82	1.43	11	1.02	5	0.70	3	1.00	5
18	6.76	325	b	400	3.57	102	3.85	118	1.70	16	1.12	7	0.75	3	1.00	5
19	4.66	165	b	310	3.87	119	2.65	52	1.93	23	1.02	5	0.75	3	0.90	4
20	3.56	101	b	290	4.77	171	4.65	164	1.83	20	1.02	5	0.75	3	0.80	3
21	3.86	119	5.89	254	5.57	224	7.25	376	1.73	17	1.10	6	0.70	3	0.70	3
22	4.06	129	4.59	160	5.27	203	5.65	229	1.63	15	1.10	6	0.70	3	0.70	3
23	4.16	135	4.79	172	4.67	166	3.95	123	1.43	11	1.10	6	0.70	3	0.70	3
24	3.46	95	4.49	154	5.27	203	3.55	100	1.53	12	1.00	5	0.70	3	0.70	3
25	2.76	58	4.49	154	4.77	171	2.95	68	1.43	11	1.00	5	0.75	3	0.75	3
26	2.56	48	4.59	160	4.47	153	2.55	47	1.33	9	0.90	4	0.75	3	0.80	3
27	3.76	113	5.99	246	4.67	164	2.25	34	1.23	7	1.80	19	0.70	3	0.80	3
28	8.96	674	6.29	280	6.87	327	1.95	24	1.03	5	3.10	75	0.75	3	0.90	4
29	9.76	748	....	...	6.37	287	2.95	68	1.03	5	4.40	149	0.75	3	5.10	191
30	9.36	708	....	...	5.47	217	2.35	38	1.03	5	2.70	55	0.70	3	7.50	411
31	8.56	637	....	...	6.42	292	....	..	0.83	3	....	..	0.65	2	8.30	608

a. Interpolated. b. Chain stolen, gage heights missing, discharge estimated.
Discharges are based on a provisional discharge curve, and are subject to revision.

Estimated Monthly Discharge of Cussewago Creek above Meadville, Pa.

[Drainage area, 102 square miles.]

Month	Discharge in second-feet Maximum	Discharge in second-feet Minimum	Discharge in second-feet Mean	Run-off Second-feet per square mile	Run-off Depth in inches
1910					
May	707	34	129	1.265	1.365
June	577	3	83	0.814	0.908
July	25	2	4	0.042	0.048
August	9	2	3	0.025	0.029
September	16	2	5	0.046	0.051
October	305	2	55	0.539	0.621
November	752	115	429	4.206	4.693
December	810	128	266	2.608	3.008
1911					
January	818	48	458	4.490	5.176
February	727	43	218	2.137	2.226
March	327	59	160	1.569	1.809
April	602	24	175	1.709	1.907
May	208	3	122	1.196	1.379
June	162	5	26	0.255	0.285
July	22	2	5	0.044	0.051
August	608	2	42	0.411	0.474

NORTH BRANCH FRENCH CREEK AT KIMMEYTOWN, PA.

This station, situated on the steel highway bridge at Kimmeytown, Crawford County, Pa., 5 miles above the mouth of the creek, was established May 4, 1910, by H. P. Drake, for the Flood Commission.

A chain gage, measuring 16.3 feet from marker to bottom of weight, is used. The zero of the gage is at an elevation of 1,235.70. The elevation of the bench mark on the west abutment, downstream side, top of caisson, is 1,250.09.

Measurements are taken from the downstream side of the bridge at ordinary stages and by wading at a point about 200 feet above the station at extremely low stages. The initial point for soundings is the outer face of caisson at left end of bridge.

The channel of the creek is straight for a distance of 300 feet above and 600 feet below the station. The bed of the creek is gravelly and permanent. The banks are both subject to overflow at extremely high stages. The greatest range of gage heights is about 13 feet.

The gage is read daily by J. L. Carter.

The drainage area above the station is 212 square miles.

Discharge Measurements of North Branch French Creek at Kimmeytown, Pa.

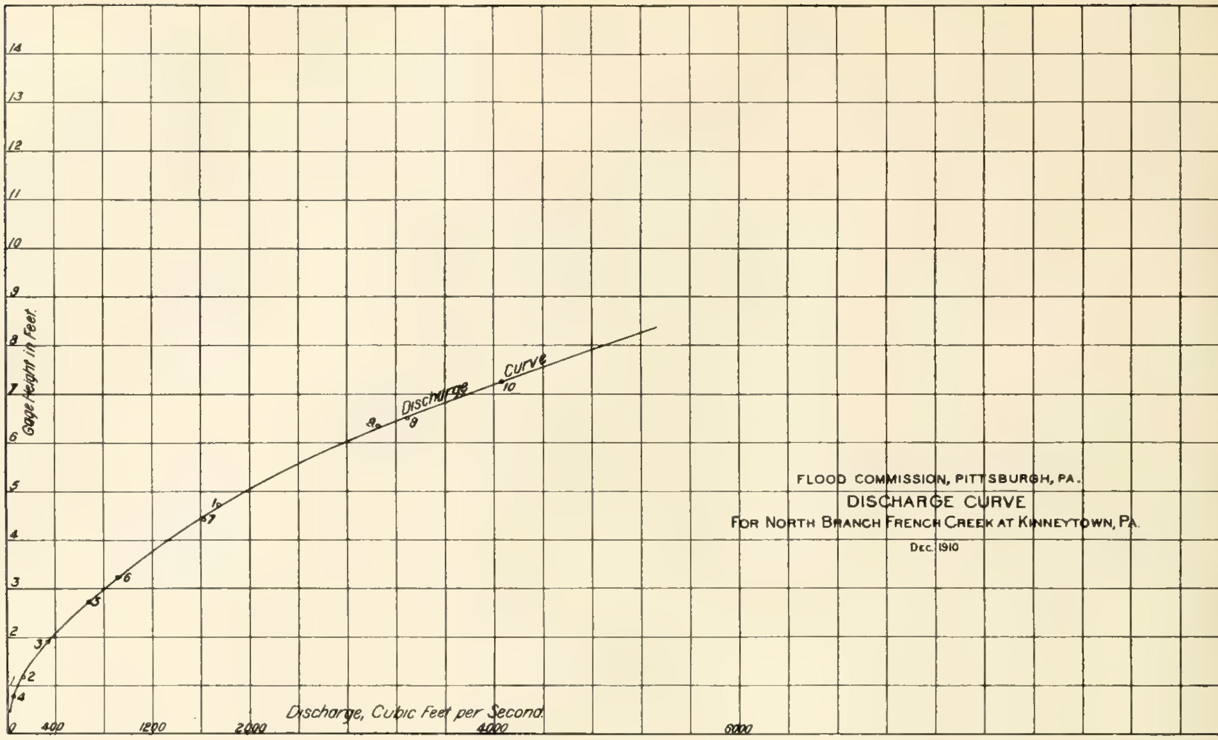
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
May	4	H. P. Drake	156	611	3.15	4.73	1753
May	28	do	124	118	1.24	1.20	139
June	13	do	131	127	2.51	1.90	345
Aug.	12	do	100	61	0.88	0.80	54
Oct.	29	do	140	315	2.15	2.74	680
Nov.	14	do	140	381	2.44	3.22	931
Dec.	31	do	155	553	2.92	4.41	1631
1911							
Jan.	3	do	168	882	3.55	6.51	3303
Jan.	14	do	168	842	3.62	6.36	3060
Jan.	14	do	168	1006	4.04	7.29	4065
June	21a	do	100	57	1.30	0.91	75

a. Wading measurement.

Rating Table for North Branch French Creek at Kimmeytown, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.40	20	1.80	305	3.20	910	4.60	1695	6.00	2760
.50	27	.90	345	.30	960	.70	1760	.10	2860
.60	35	2.00	380	.40	1010	.80	1825	.20	2960
.70	44	.10	415	.50	1060	.90	1890	.30	3060
.80	54	.20	455	.60	1115	5.00	1960	.40	3160
.90	70	.30	495	.70	1170	.10	2030	.50	3260
1.00	90	.40	535	.80	1225	.20	2105	.60	3365
.10	110	.50	575	.90	1280	.30	2180	.70	3470
.20	130	.60	620	4.00	1335	.40	2260	.80	3580
.30	155	.70	665	.10	1390	.50	2340	.90	3690
.40	180	.80	710	.20	1445	.60	2420	7.00	3805
.50	210	.90	760	.30	1505	.70	2500	...	....
.60	240	3.00	810	.40	1565	.80	2585	...	....
.70	275	.10	860	.50	1630	.90	2670	...	....

PLATE 102



Daily Gage Heights and Discharges of North Branch French Creek at Kimmeytown, Pa., for 1910.

Day	May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	2.35	515	0.82	57	0.71	45	0.80	54	0.70	44	2.90	760	2.70	665
2	....	....	2.95	785	0.82	57	0.71	45	0.80	54	0.70	44	4.90	1890	2.70	665
3	....	....	3.15	890	0.82	57	0.71	45	0.90	70	0.70	44	4.30	1505	2.50	575
4	....	....	1.95	352	0.72	46	0.71	45	1.10	110	0.80	54	3.00	810	2.50	575
5	....	....	1.95	352	0.72	46	0.71	45	1.30	155	0.80	54	2.20	455	2.40	535
6	....	....	2.25	475	0.82	57	0.71	45	2.90	760	0.80	54	2.10	415	2.30	495
7	....	....	2.35	515	0.82	57	0.71	45	2.90	760	0.80	54	1.90	345	2.40	535
8	....	....	2.14	431	0.71	45	0.71	45	1.90	345	1.30	155	2.00	380	2.20	455
9	....	....	1.84	319	0.71	45	0.81	56	1.30	155	1.20	130	2.40	535	2.30	495
10	....	....	1.64	254	0.71	45	1.00	90	1.80	305	1.00	90	4.90	1890	2.20	455
11	....	....	1.74	289	0.91	72	0.90	70	1.70	275	1.00	90	9.30	6565	2.10	415
12	....	....	2.24	471	0.71	45	0.90	70	1.60	240	0.80	54	5.00	1960	2.10	415
13	....	....	1.94	359	0.81	56	0.80	54	1.50	210	0.80	54	4.10	1390	2.10	415
14	....	....	1.53	219	1.01	92	0.70	44	1.30	155	0.70	44	3.20	910	2.30	495
15	....	....	1.33	162	1.01	92	0.70	44	1.20	130	0.80	54	3.10	860	2.20	455
16	1.18	126	1.23	137	1.01	92	0.70	44	1.00	90	0.80	54	2.90	760	2.40	535
17	1.18	126	1.13	116	1.11	112	0.90	70	0.90	70	0.80	54	2.80	710	2.90	760
18	1.27	147	1.13	116	0.91	72	0.80	54	0.80	54	0.70	44	2.70	665	2.90	760
19	1.27	147	1.03	96	0.91	72	0.70	44	0.80	54	0.70	44	2.60	620	2.90	760
20	1.17	124	1.03	96	0.91	72	0.70	44	0.80	54	0.70	44	2.50	575	3.10	860
21	1.17	124	0.93	76	1.01	92	0.70	44	0.70	44	0.70	44	2.40	535	3.20	910
22	1.17	124	0.83	59	1.01	92	0.70	44	0.70	44	0.90	70	2.30	495	3.20	910
23	1.27	147	0.93	76	0.91	72	0.70	44	0.80	54	1.10	110	2.30	495	3.10	860
24	1.26	145	0.93	76	0.91	72	0.70	44	0.80	54	1.20	130	3.40	1010	3.40	1010
25	1.36	170	0.92	74	0.91	72	0.70	44	0.70	44	1.30	155	4.30	1505	3.60	1115
26	1.46	198	0.82	57	0.81	56	0.70	44	0.70	44	1.90	345	4.50	1630	3.80	1225
27	1.26	145	0.82	57	0.81	56	0.70	44	0.70	44	1.70	275	3.70	1170	3.70	1170
28	1.16	122	0.82	57	0.71	45	0.70	44	0.70	44	2.20	455	2.80	710	3.40	1010
29	1.05	100	0.82	57	0.71	45	0.70	44	0.70	44	2.80	710	3.10	860	4.90	1890
30	1.15	120	0.82	57	0.71	45	0.70	44	0.80	54	2.60	620	2.80	710	4.80	1825
31	2.25	475	....	....	0.71	45	0.70	44	....	....	2.40	535	....	....	4.40	1565

Daily Gage Heights and Discharges of North Branch French Creek at Kimmeytown, Pa., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.50	1630	2.90	760	2.00	380	2.50	575	2.30	495	0.90	70	0.90	70	0.70	44
2	4.60	1695	2.40	535	2.00	380	b2.40	535	2.70	665	0.90	70	0.80	54	0.70	44
3	6.50	2340	2.20	455	1.80	305	2.20	455	2.70	665	1.00	90	0.80	54	1.10	110
4	5.00	1960	2.10	415	1.50	210	2.30	495	2.20	455	1.00	90	0.80	54	0.90	70
5	3.60	1115	2.00	380	b1.50	210	4.80	1825	1.80	305	1.10	110	0.80	54	0.90	70
6	3.30	960	1.90	345	1.60	240	5.50	2340	1.60	240	1.30	155	0.80	54	0.90	70
7	3.00	810	1.90	345	1.40	180	4.70	1760	1.50	210	1.20	130	0.80	54	1.00	90
8	2.80	710	2.00	380	1.50	210	3.60	1115	1.40	180	1.10	110	0.80	54	0.90	70
9	2.70	665	1.70	275	b1.70	275	b3.40	1010	1.20	130	1.00	90	0.80	54	0.80	54
10	2.90	760	1.70	275	3.10	860	2.80	710	1.30	155	1.00	90	0.80	54	0.80	54
11	2.60	620	1.60	240	3.20	910	2.50	575	1.30	155	1.10	110	0.80	54	0.80	54
12	6.90	3690	1.60	240	b3.60	1115	2.20	455	1.30	155	1.40	180	0.70	44	0.80	54
13	6.80	3580	1.60	240	3.90	1280	2.00	380	1.40	180	1.30	155	0.70	44	0.80	54
14	6.20	2960	1.60	240	3.40	1010	2.00	380	1.30	155	1.20	130	0.70	44	0.70	44
15	7.40	4265	4.30	1505	3.10	860	2.40	535	1.20	130	1.20	130	0.70	44	0.70	44
16	4.40	1565	3.90	1280	2.20	455	2.20	455	1.20	130	1.10	110	0.80	54	1.70	275
17	3.70	1170	4.40	1565	3.20	910	1.90	345	1.20	130	1.00	90	0.80	54	1.60	240
18	3.00	810	8.70	5840	2.20	455	1.80	305	1.10	110	1.20	130	0.80	54	1.40	180
19	2.90	760	4.70	1760	b2.10	415	1.70	275	1.20	130	1.30	155	0.80	54	1.10	110
20	2.70	665	3.40	1010	2.10	415	3.70	1170	1.10	110	1.10	110	0.80	54	1.00	90
21	2.60	620	2.50	575	3.40	1010	3.40	1010	1.10	110	1.00	90	0.90	70	0.90	70
22	2.60	620	2.20	455	3.40	1010	2.50	575	1.00	90	0.90	70	0.90	70	0.80	54
23	2.60	620	2.10	415	4.00	1335	2.30	495	1.10	110	0.80	54	0.80	54	0.80	54
24	2.20	455	2.30	495	2.90	760	2.00	380	1.20	130	0.80	54	0.80	54	0.80	54
25	2.20	455	2.00	380	2.40	535	1.80	305	1.10	110	0.80	54	0.80	54	0.90	70
26	1.80	305	b2.50	575	b3.00	810	1.60	240	1.10	110	0.90	70	0.80	54	1.00	90
27	5.95	2715	3.00	810	3.40	1010	1.50	210	1.00	90	0.90	70	0.70	44	1.00	90
28	a11.30	9190	2.50	575	4.90	1890	1.40	180	1.00	90	1.10	110	0.70	44	1.00	90
29	5.30	2180	....	...	3.20	910	1.40	180	0.90	70	1.00	90	0.70	44	3.90	1280
30	4.90	1890	....	...	3.00	810	b1.40	180	0.90	70	0.90	70	0.80	54	2.80	710
31	3.40	1010	....	...	2.60	620	....	...	0.90	70	....	..	0.70	44	1.90	345

a. Max. 7.40 A. M., 11.3. b. Interpolated.

Estimated Monthly Discharge of North Branch French Creek at Kimmeytown, Pa.

[Drainage area, 212 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
June	890	57	253	1.195	1.334
July	112	45	63	0.297	0.335
August	90	44	49	0.231	0.266
September	760	44	152	0.717	0.799
October	710	44	152	0.717	0.826
November	6565	345	1104	5.200	5.802
December	1890	415	800	3.775	4.352
1911					
January	9190	305	1703	8.033	9.261
February	5840	240	799	3.769	3.925
March	1890	180	708	3.339	3.850
April	2340	180	648	3.057	3.411
May	665	70	191	0.901	1.039
June	180	70	101	0.476	0.531
July	70	44	52	0.245	0.283
August	1280	44	152	0.717	0.827

OIL CREEK AT ROUSEVILLE, PA.

This station, situated on the steel highway bridge at McClintockville, Venango County, Pa., one-half mile below Rouseville, and 2.5 miles above the mouth was established by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh, October 20, 1909.

A staff gage, 14 feet long, is bolted to the face of the right abutment. The zero of the gage is 15.76 feet below the iron bed-plate of right abutment, downstream side, and 1.46 feet below the top corner of upstream end of stone in bottom course at downstream corner of right abutment.

Measurements are taken from the downstream side of bridge at ordinary stages and by wading at extreme low stages. The initial point for soundings is on the top edge of right bridge seat.

The channel is straight for 200 feet above and 1,000 feet below the station. A trolley bridge crosses the creek 400 feet above the station. The right bank overflows at extremely high stages, but the left bank is high and does not overflow. The bed of the stream is gravelly and fairly permanent. The velocity is very low at low stages. The greatest range of gage heights is about 13 feet.

The gage is read twice daily by C. H. Wright.

The drainage area above the station is 302 square miles.

Discharge Measurements of Oil Creek at Rouseville, Pa.

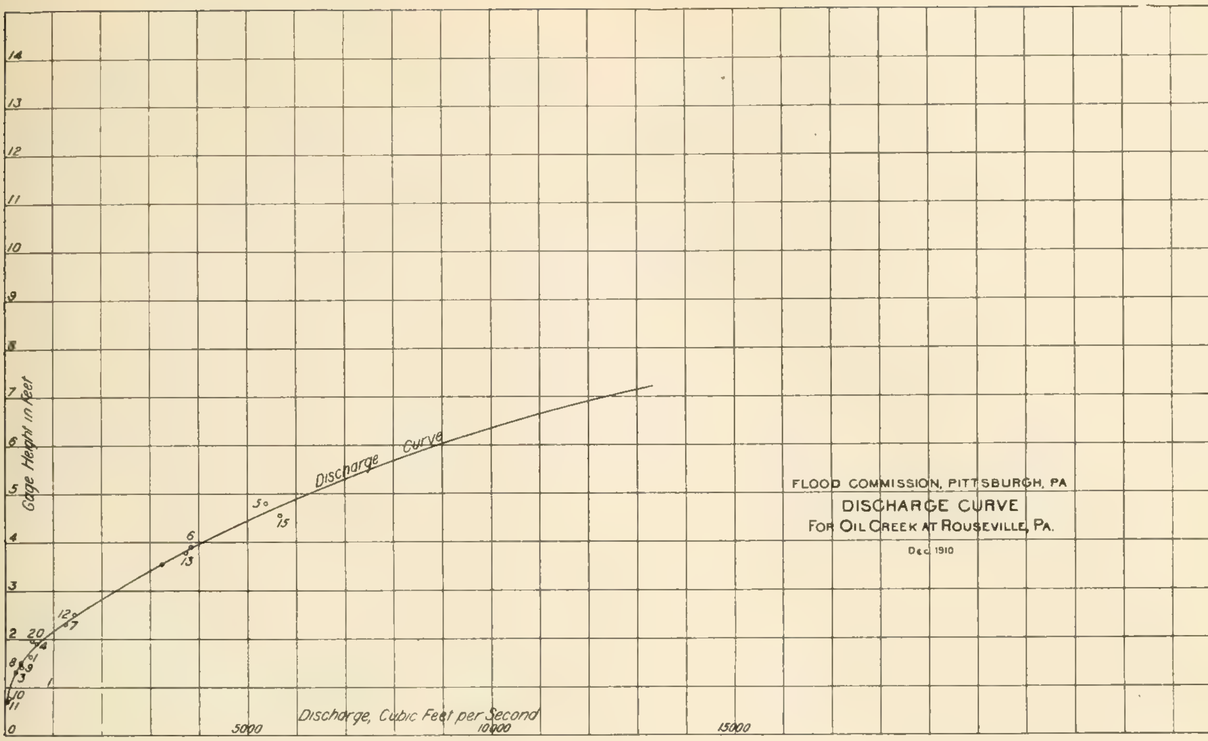
Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
1910		*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Feb. 1	K. C. Grant	181	465	1.11	1.61	515
Feb. 4	H. P. Drake	182	581	0.99	1.95	544
Feb. 12	do	181	479	0.43	1.30	204
Feb. 22	do	181	589	1.13	1.90	632
Feb. 28	do	182	1123	4.80	4.80	5391
Mar. 4	do	182	956	4.22	3.90	3830
Mar. 11	do	182	666	1.80	2.30	1255
Apr. 7	do	182	517	0.63	1.50	310
June 14	do	182	502	0.67	1.40	336
July 12a	C. E. Ryder	...	78	1.14	0.77	89
Aug. 13	H. P. Drake	182	372	0.15	0.70	57
Nov. 3	do	188	683	2.08	2.50	1420
Dec. 30	do	182	923	4.03	3.79	3717
1911						
Jan. 2	do	182	896	3.61	3.55	3230
Jan. 15	do	182	1077	5.26	4.56	5679
June 20	do	172	387	0.19	0.75	74

a. Wading measurement.

Rating Table for Oil Creek at Rouseville, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.50	39	1.70	475	2.90	2140	4.10	4285	5.30	7045
.60	49	.80	565	3.00	2300	.20	4490	.40	7300
.70	59	.90	665	.10	2465	.30	4700	.50	7560
.80	70	2.00	780	.20	2630	.40	4915	.60	7830
.90	88	.10	900	.30	2800	.50	5135	.70	8100
1.00	110	.20	1040	.40	2975	.60	5360	.80	8370
.10	140	.30	1180	.50	3150	.70	5590	.90	8640
.20	180	.40	1340	.60	3325	.80	5820	6.00	8910
.30	230	.50	1500	.70	3500	.90	6055	....	....
.40	280	.60	1660	.80	3685	5.00	6300	....	....
.50	330	.70	1820	.90	3880	.10	6545	....	....
.60	395	.80	1980	4.00	4080	.20	6795	....	....

PLATE 103



Daily Gage Heights and Discharges of Oil Creek at Rouseville, Pa., for 1909.

Day	November		December		Day	October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.68	57	0.80	70	17	....	....	0.87	83	1.10	150
2	0.71	60	0.80	70	18	....	....	1.15	160	1.00	110
3	0.72	61	0.70	59	19	....	....	0.98	105	1.00	110
4	0.70	59	0.80	70	20	0.70	59	1.10	140	1.00	110
5	0.73	62	0.80	70	21	0.72	61	1.45	305	1.00	110
6	0.74	64	0.80	70	22	0.77	67	1.90	665	0.90	88
7	0.75	65	0.80	70	23	0.85	79	1.90	665	0.90	88
8	0.78	68	0.90	88	24	0.83	75	1.45	305	0.90	88
9	0.85	79	0.90	88	25	0.84	77	1.20	180	0.80	70
10	0.91	90	0.90	88	26	0.81	72	1.10	140	0.80	70
11	0.86	80	0.90	88	27	0.79	69	1.00	110	0.80	70
12	0.78	68	0.90	88	28	0.75	65	0.90	88	0.70	59
13	0.76	66	1.05	140	29	0.72	61	0.80	70	0.70	59
14	0.74	64	2.30	1180	30	0.70	59	0.80	70	0.70	59
15	0.75	65	1.50	330	31	0.68	57	....	....	0.70	59
16	0.75	65	1.25	205							

Daily Gage Heights and Discharges of Oil Creek at Rouseville, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.80	70	1.60	395	d 5.40	7300	1.50	330	1.60	395	1.50	330
2	0.95	99	1.75	520	4.75	5705	1.40	280	2.50	1500	1.70	475
3	1.45	305	1.80	565	4.55	5245	1.35	255	2.25	1110	2.65	1740
4	1.50	330	1.90	665	4.05	4180	1.30	230	3.05	2380	2.30	1180
5	1.50	330	1.75	520	3.90	3880	1.55	360	2.35	1260	1.85	615
6	1.60	395	1.60	395	4.30	4700	1.55	360	2.00	780	1.70	475
7	1.35	255	1.50	330	5.05	6420	1.45	305	1.75	520	1.55	360
8	1.30	230	1.40	280	3.85	3780	1.35	255	1.65	435	1.45	305
9	1.20	180	1.50	330	2.90	2140	1.40	280	1.60	395	1.40	280
10	1.20	180	1.40	280	2.50	1500	1.40	280	1.50	330	1.40	280
11	1.20	180	1.30	230	2.45	1420	1.30	230	1.45	305	1.60	395
12	1.15	160	1.30	230	2.35	1260	1.30	230	1.40	280	1.90	665
13	1.10	140	1.30	230	2.50	1500	1.20	180	1.40	280	1.70	475
14	1.10	140	1.30	230	2.35	1260	1.15	160	1.30	230	1.45	310
15	1.00	110	1.35	255	2.20	1040	1.10	140	1.25	205	1.40	280
16	1.05	125	1.65	435	2.05	840	1.20	180	1.15	160	1.50	330
17	1.30	230	1.90	665	2.00	780	1.20	180	1.10	140	1.40	280
18	a 3.25	2715	1.90	665	1.85	615	1.20	180	1.15	160	1.35	255
19	b	....	1.75	520	1.95	720	1.35	255	1.30	230	1.25	205
20	b	....	1.80	565	2.90	2140	1.50	330	1.20	180	1.10	140
21	b	....	1.85	615	3.05	2380	1.55	360	1.30	230	1.00	110
22	b	....	1.95	720	2.60	1660	1.75	520	1.20	180	0.95	99
23	b	....	1.90	665	2.45	1420	1.65	435	1.40	280	0.90	88
24	b	....	1.65	435	2.35	1260	1.55	360	1.55	360	0.90	88
25	b	....	1.55	360	2.15	970	2.55	1580	1.70	475	0.90	88
26	2.40	1340	1.55	360	2.05	840	3.40	2975	1.65	435	0.85	79
27	2.30	1180	1.95	720	1.95	720	2.45	1420	1.55	360	0.85	79
28	2.30	1180	c4.55	5245	1.85	615	2.05	840	1.45	305	0.85	79
29	2.20	1040	....	....	1.75	520	1.85	615	1.35	255	0.82	73
30	2.15	970	....	....	1.60	395	1.70	475	1.35	255	0.80	70
31	1.95	720	....	....	1.55	360	....	..	1.50	330	....	..

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.80	70	0.80	70	0.68	57	0.75	65	1.75	520	1.95	720
2	0.80	70	0.80	70	0.65	54	0.70	59	2.35	1260	1.75	520
3	0.80	70	0.80	70	0.68	57	0.70	59	2.65	1740	1.70	475
4	0.80	70	0.80	70	0.85	79	0.70	59	1.75	520	1.55	360
5	0.80	70	0.78	68	0.90	88	0.80	70	1.45	305	1.50	330
6	0.78	67	0.75	65	0.88	84	1.10	140	1.25	205	1.45	305
7	0.85	79	0.75	65	0.95	99	1.75	520	1.05	130	1.35	255
8	1.05	130	0.70	59	0.82	74	1.70	475	1.25	205	1.30	230
9	0.90	88	0.70	59	0.80	70	1.30	230	1.25	205	1.30	230
10	0.85	79	0.72	61	0.80	70	0.95	99	1.50	330	1.25	205
11	0.80	70	0.80	70	0.78	68	0.80	70	2.80	1980	1.40	280
12	0.80	70	0.78	68	0.72	61	0.80	70	2.35	1260	1.40	280
13	1.05	130	0.72	61	0.70	59	0.80	70	1.95	720	1.35	255
14	1.05	130	0.70	59	0.70	59	0.80	70	2.00	780	1.35	255
15	0.90	88	0.70	59	0.70	59	0.78	68	1.85	610	1.25	205
16	0.80	70	0.65	54	0.70	59	0.75	65	1.75	520	1.25	205
17	0.80	70	0.65	54	0.70	59	0.70	59	1.65	435	1.25	205
18	0.85	79	0.65	54	0.68	57	0.70	59	1.80	565	1.20	180
19	0.80	70	0.68	57	0.65	54	0.70	59	1.65	435	1.30	230
20	0.80	70	0.70	59	0.65	54	0.70	59	1.60	395	1.35	255
21	0.80	70	0.65	54	0.65	54	0.70	59	1.60	395	1.30	230
22	0.80	70	0.60	49	0.65	54	0.85	79	1.60	395	1.25	205
23	0.88	84	0.60	49	0.62	51	1.10	140	1.60	395	1.25	205
24	0.90	88	0.60	49	0.78	68	0.95	99	2.20	1040	1.55	360
25	0.85	79	0.60	49	1.05	130	1.05	130	3.05	2380	1.75	520
26	0.90	88	0.75	65	1.05	130	1.55	360	3.00	2300	1.60	395
27	0.90	88	0.75	65	0.88	84	1.55	360	2.35	1260	1.60	395
28	0.88	84	0.70	59	0.80	70	1.35	255	2.00	780	1.60	395
29	0.82	74	0.70	59	0.80	70	1.55	360	2.30	1180	3.20	2630
30	0.90	88	0.70	59	0.80	70	1.60	395	2.05	840	3.90	3880
31	0.90	88	0.70	59	....	..	1.75	520	....	...	2.90	2140

a. Max. 4 P.M., 4.2 = 4490 sec.-ft.
b. Gage carried out by ice.
c. Max. 6 P.M. 5.0 = 6300 sec.-ft.
d. Max. 11:30 P.M., 5.8 = 8370 sec.-ft.

Daily Gage Heights and Discharges of Oil Creek at Rouseville, Pa., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.15	970	2.10	900	1.55	355	1.95	725	1.60	395	0.85	79	1.00	110	0.60	49
2	3.10	2465	1.95	725	1.65	435	1.95	725	2.10	900	0.80	70	0.90	88	0.60	49
3	4.10	4285	1.75	520	1.55	355	1.75	520	2.00	780	0.80	70	0.80	70	0.80	70
4	2.90	2140	1.95	725	1.40	280	1.90	665	1.80	565	0.80	70	0.80	70	0.95	99
5	2.35	1260	1.80	565	1.35	255	3.30	2800	1.60	395	0.90	88	0.80	70	0.90	88
6	2.05	840	1.60	395	1.35	255	3.05	2380	1.50	330	0.90	88	0.80	70	0.80	70
7	1.95	725	1.60	395	1.20	180	2.90	2140	1.40	280	0.90	88	0.80	70	0.80	70
8	1.80	565	1.55	355	1.30	230	2.50	1500	1.30	230	0.90	88	0.90	88	0.80	70
9	1.90	665	1.45	305	1.25	205	2.15	970	1.30	230	0.80	70	0.80	70	0.70	59
10	1.70	475	1.40	280	1.90	665	2.15	970	1.20	180	0.80	70	0.70	59	0.62	51
11	1.65	435	1.30	230	2.10	900	2.05	840	1.20	180	0.80	70	0.75	64	0.60	49
12	4.00	4080	1.20	180	2.15	970	1.85	615	1.20	180	1.00	110	0.85	79	0.60	49
13	4.00	4080	1.25	205	2.30	1180	1.80	565	1.10	140	1.20	180	0.75	64	0.60	49
14	4.50	5135	1.50	330	2.10	900	1.95	725	1.10	140	1.00	110	0.70	59	0.60	49
15	4.70	5590	3.15	2545	2.00	780	2.25	1110	1.00	110	0.90	88	0.70	59	0.70	59
16	3.00	2300	2.75	1900	1.65	435	2.00	780	1.00	110	0.80	70	0.70	59	1.25	205
17	2.40	1340	2.85	2060	1.55	355	1.90	665	1.00	110	0.80	70	0.70	59	0.95	99
18	1.95	725	4.00	4080	1.80	565	1.75	520	1.10	140	0.80	70	0.70	59	0.90	88
19	1.95	725	2.95	2220	1.70	475	1.65	435	1.00	110	0.80	70	0.70	59	0.80	70
20	1.75	520	2.25	1110	1.65	435	2.65	1740	1.00	110	0.70	59	0.75	64	0.70	59
21	1.80	565	2.05	840	2.25	1110	2.40	1340	1.10	140	0.70	59	0.75	64	0.70	59
22	1.85	615	1.85	615	2.15	970	2.10	900	1.00	110	0.70	59	0.75	64	0.60	49
23	1.60	395	1.70	475	2.70	1820	2.20	1040	1.00	110	0.70	59	0.70	59	0.60	49
24	1.35	255	1.60	395	1.95	725	2.00	780	1.00	110	0.70	59	0.75	64	0.75	64
25	1.45	305	1.65	435	1.80	565	1.85	615	1.00	110	1.60	49	0.75	64	1.10	140
26	1.40	280	1.75	520	1.95	725	1.70	475	0.90	88	1.40	280	0.70	59	1.30	230
27	1.60	395	2.05	840	2.55	1580	1.60	395	0.90	88	1.50	330	0.70	59	0.95	99
28	4.95	6175	1.80	565	2.85	2060	1.55	360	0.90	88	1.90	665	0.70	59	1.35	255
29	2.95	2220	....	...	2.30	1180	1.50	330	0.90	88	1.40	280	0.60	49	4.55	5247
30	3.00	2300	....	...	2.15	970	1.65	435	0.80	70	1.10	140	0.60	49	2.35	1260
31	2.40	1340	....	...	2.10	900	....	...	0.80	70	....	...	0.60	49	1.70	475

Estimated Monthly Discharge of Oil Creek at Rouseville, Pa.

[Drainage area, 302 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
November	665	57	139	0.460	0.404
December	1180	59	132	0.513	0.466
1910					
January	4490	70	....	....	....
February	6300	230	622	2.059	2.144
March	8370	375	2179	7.215	8.318
April	2975	150	486	1.605	1.790
May	2380	150	475	1.573	1.814
June	1740	70	341	1.129	1.260
July	130	67	82	0.271	0.312
August	70	49	61	0.202	0.233
September	130	51	70	0.232	0.259
October	515	59	169	0.560	0.646
November	2380	130	803	2.659	2.967
December	3880	190	559	1.851	2.134
11 months	8370	49	532	1.759	21.877

Estimated Monthly Discharge of Oil Creek at Rouseville, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1911					
January	6175	255	1673	5.539	6.386
February	4080	180	883	2.923	3.044
March	2060	180	736	2.437	2.812
April	2800	330	935	3.096	3.455
May	900	70	216	0.715	0.824
June	665	70	122	0.404	0.451
July	110	49	65	0.215	0.248
August	5247	49	302	1.000	1.153

TIONESTA CREEK AT NEBRASKA, PA.

This station, situated at the lower end of the lumber yard at Nebraska, Forest County, Pa., 7 miles above the mouth of the creek, was established by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh, October 21, 1909.

A rod gage, with its zero at an elevation of 1077.78, is spiked to an oak tree on the right bank at the lower end of the lumber yard. Low readings are made from an iron rail, driven into the bed of the creek 30 feet out from the tree. Top of rail is 2.70 feet above zero of gage. Elevation of bench mark on root of lone oak tree on right bank, 150 feet below small dam opposite lumber yard, is 1087.34.

Measurements are made from the highway bridge above the mill at ordinary stages and by wading opposite the gage, or just above the bridge, at very low stages.

The bed of the creek is stony and permanent. The channel above and below the gage curves gradually to the right. The right bank overflows at extreme high water, but the left bank is high and does not overflow. The greatest range of gage heights is about 18 feet.

The gage is read daily by I. H. Allison.

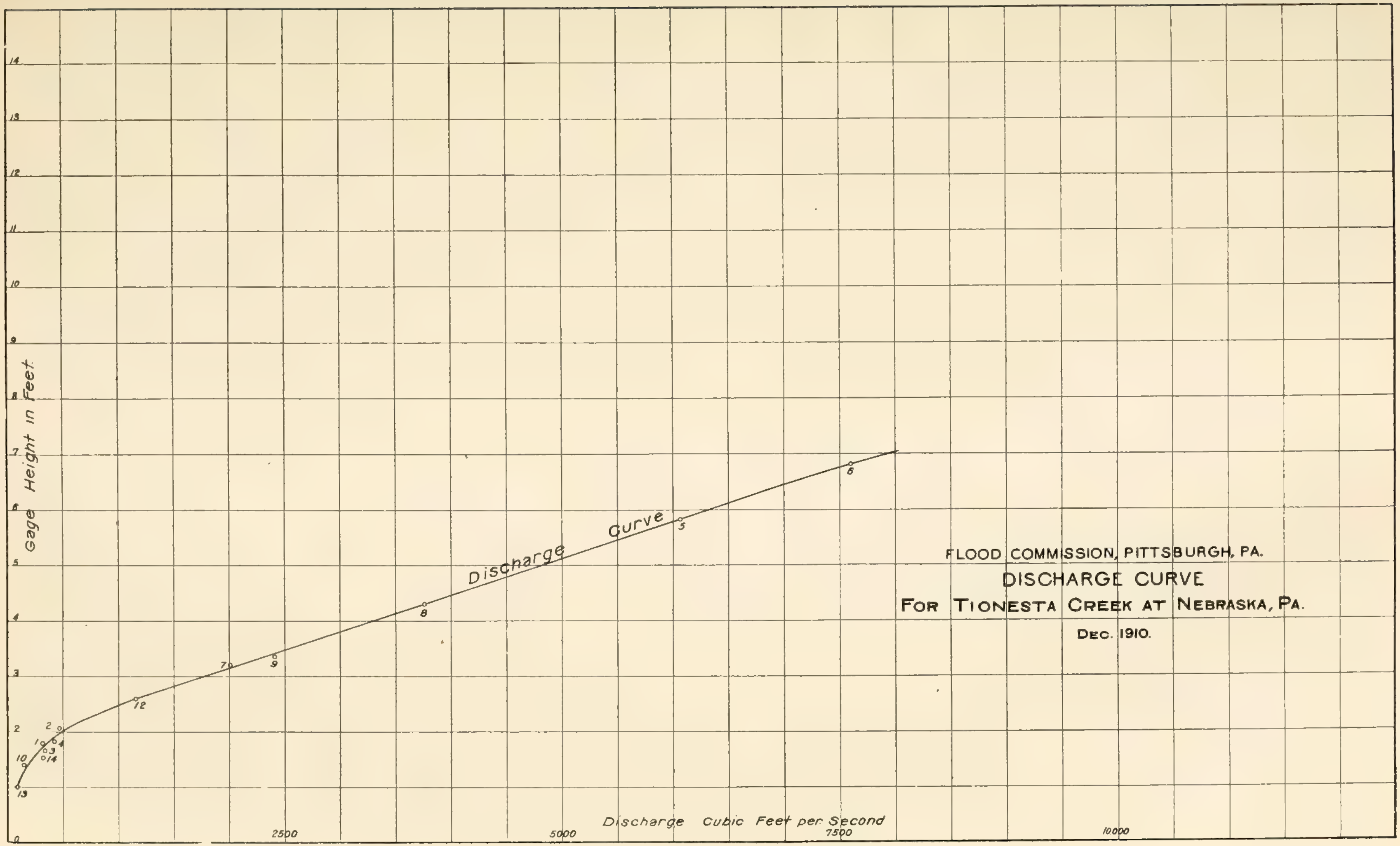
The drainage area above the station is 451 square miles.

Discharge Measurements of Tionesta Creek at Nebraska, Pa.

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
		Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1910						
Feb. 5	H. P. Drake	112	373	1.05	2.08	469
Feb. 7	do	112	381	0.90	1.65	333
Feb. 11	do	112	401	0.81	1.80	318
Feb. 16	do	112	413	1.05	1.84	421
Mar. 2	do	112	1053	6.06	5.80	6075
Mar. 7	do	112	1188	6.72	6.80	7606
Mar. 14	do	112	661	3.21	3.20	2010
Mar. 21	do	112	873	4.54	4.30	3762
Mar. 28	do	112	694	3.65	3.35	2410
Apr. 11	do	104	327	0.61	1.40	191
May 7	do	112	549	2.23	2.60	1162
June 15	do	112	397	0.89	1.72	351
Aug. 15a	do	91	82	0.96	1.00	79
Nov. 21a	do	...	...	....	1.52	319
1911						
June 20a	do	107	297	0.40	1.22	140

a. Wading measurement.

PLATE 104


FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR TIONESTA CREEK AT NEBRASKA, PA.
DEC. 1910.
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
0
2500
5000
7500
10000
2
3
4
5
6
7
8
9
10
11
12
13
14

Rating Table for Tionesta Creek at Nebraska, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.80	45	2.10	560	3.40	2395	4.70	4365	6.00	6350
0.90	61	.20	660	.50	2550	.80	4520	.10	6505
1.00	79	.30	780	.60	2700	.90	4675	.20	6655
.10	100	.40	900	.70	2850	5.00	4830	.30	6810
.20	125	.50	1030	.80	3000	.10	4985	.40	6960
.30	150	.60	1165	.90	3155	.20	5140	.50	7115
.40	180	.70	1310	4.00	3305	.30	5295	.60	7275
.50	215	.80	1465	.10	3460	.40	5450	.70	7440
.60	255	.90	1620	.20	3615	.50	5605	.80	7615
.70	300	3.00	1775	.30	3765	.60	5760	.90	7795
.80	350	.10	1930	.40	3915	.70	5915	7.00	7975
.90	410	.20	2085	.50	4065	.80	6070	...	....
2.00	480	.30	2240	.60	4215	.90	6225	...	....

Daily Gage Heights and Discharges of Tionesta Creek at Nebraska, Pa., for 1909.

Day	November		December		Day	October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge		Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1....	1.00	79	1.21	127	17....	....	....	1.10	100	1.73	315
2....	1.00	79	1.18	120	18....	....	....	1.28	145	1.88	392
3....	1.00	79	1.09	98	19....	....	....	1.27	140	1.80	350
4....	1.00	79	1.11	102	20....	....	....	1.20	125	1.79	345
5....	1.00	79	1.15	115	21....	....	....	1.28	145	1.78	340
6....	1.00	79	1.11	102	22....	....	....	1.70	300	1.78	340
7....	1.00	79	1.12	104	23....	....	....	1.85	380	1.76	330
8....	1.10	100	1.00	79	24....	1.30	150	1.80	350	1.72	310
9....	1.20	125	1.02	83	25....	1.30	150	1.59	251	1.72	310
10....	1.30	160	1.02	83	26....	1.10	100	1.48	208	1.68	291
11....	1.20	125	1.20	125	27....	1.20	125	1.39	177	1.65	277
12....	1.10	100	1.20	125	28....	1.10	100	1.31	152	1.65	277
13....	1.10	100	1.28	145	29....	1.10	100	1.30	150	1.70	300
14....	1.00	79	2.62	1189	30....	1.00	79	1.24	129	1.70	300
15....	1.00	79	2.00	480	31....	1.00	79	....	....	1.60	255
16....	1.10	100	1.80	350							

Daily Gage Heights and Discharges of Tionesta Creek at Nebraska, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.68	291	1.92	424	6.21	6670	2.04	512	2.50	1030	2.68	1281	1.48	208	1.42	187	1.33	159	1.34	162	1.64	281	2.58	1128
2	1.46	201	1.78	340	5.68	5884	2.30	780	3.28	2209	2.68	1281	1.46	200	1.38	173	1.28	145	1.33	159	1.78	340	2.44	952
3	1.63	269	2.00	480	5.85	6155	2.20	660	3.23	2132	3.80	3000	1.43	190	1.38	173	1.36	167	1.32	156	2.10	560	2.28	756
4	1.58	247	1.88	398	6.40	6960	2.17	630	3.32	2271	3.45	2467	1.43	190	1.34	162	1.52	223	1.32	156	1.94	438	2.23	696
5	1.60	255	2.00	480	4.82	4551	2.50	1030	3.02	1806	3.08	1899	1.40	180	1.34	162	1.56	239	1.33	159	1.75	325	2.20	660
6	1.65	277	1.78	340	5.00	4830	2.28	756	2.78	1434	3.03	1821	1.40	180	1.34	162	1.44	194	1.36	167	1.68	290	2.20	660
7	1.89	404	1.60	255	a 6.60	7275	2.18	640	2.65	1237	2.84	1527	1.64	273	1.33	159	1.43	190	1.46	201	1.63	268	1.83	368
8	1.90	410	1.65	277	4.90	4675	2.07	536	2.90	1620	2.69	1295	1.72	310	1.30	150	1.38	173	1.53	227	1.61	260	1.90	410
9	1.89	404	1.79	345	4.10	3460	1.98	466	2.78	1434	2.42	926	1.55	235	1.28	145	1.36	167	1.44	194	1.59	251	1.86	386
10	1.87	392	1.71	305	3.65	2775	1.90	410	2.66	1252	2.40	900	1.48	208	1.33	159	1.33	159	1.42	187	1.59	251	2.08	544
11	1.82	362	1.82	362	3.40	2395	1.82	362	2.50	1030	2.40	900	1.44	194	1.48	208	1.30	150	1.38	173	2.58	1138	2.11	570
12	1.89	404	1.49	212	3.31	2255	1.77	335	2.40	900	2.38	756	1.46	200	1.47	204	1.28	145	1.34	162	2.36	852	2.20	660
13	1.76	330	1.66	282	3.35	2317	1.72	310	2.32	804	2.23	696	2.53	1070	1.40	180	1.28	145	1.33	159	2.16	620	2.10	560
14	1.84	374	1.60	255	3.15	2007	1.65	277	2.28	756	2.14	600	2.06	528	1.38	173	1.25	137	1.33	159	2.10	560	2.28	756
15	1.84	374	1.61	260	2.92	1651	1.60	255	2.20	660	2.08	544	1.68	290	1.38	173	1.25	137	1.32	156	2.08	544	2.31	792
16	1.87	392	1.75	325	2.73	1355	1.74	320	2.08	544	2.04	512	1.45	197	1.33	159	1.25	137	1.32	156	2.06	528	2.22	684
17	1.79	345	2.32	804	2.76	1403	1.66	282	2.04	512	1.98	466	1.53	227	1.28	145	1.24	135	1.30	150	2.03	504	2.23	696
18	3.71	2865	2.24	708	2.80	1465	1.90	410	2.21	672	1.95	445	1.53	227	1.26	140	1.23	132	1.30	150	1.99	473	2.46	978
19	4.70	4365	2.22	684	2.96	1713	2.00	480	2.23	696	1.91	417	1.48	208	1.26	140	1.23	132	1.30	150	1.96	452	2.38	876
20	4.00	3305	2.09	552	4.90	4675	2.30	780	2.08	544	1.84	374	1.48	208	1.28	145	1.23	132	1.28	145	1.93	431	2.44	952
21	3.65	2775	2.24	708	4.30	3765	2.63	1208	2.12	580	1.75	325	1.48	208	1.33	159	1.23	132	1.28	145	1.96	452	2.52	1057
22	3.96	3245	2.80	1465	4.03	3352	2.70	1310	2.08	544	1.68	290	1.40	180	1.33	159	1.23	132	1.38	173	1.98	466	2.40	900
23	3.50	2550	2.62	1194	4.02	3337	2.53	1071	3.32	2271	1.66	282	1.58	247	1.31	153	1.23	132	1.64	281	1.96	452	2.36	852
24	3.08	1899	2.40	900	4.03	3352	2.66	1252	2.80	1465	1.58	247	1.44	194	1.31	153	1.40	180	1.52	223	2.18	640	2.33	816
25	2.70	1310	2.31	792	4.60	4215	3.90	3155	2.99	1760	1.56	239	1.40	180	1.28	145	1.78	340	1.54	231	2.48	1004	2.24	708
26	2.62	1194	2.23	696	4.30	3765	4.00	3305	2.69	1295	1.54	231	1.66	282	1.35	165	1.74	320	1.70	300	2.48	1004	2.28	756
27	2.75	1388	2.54	1084	3.65	2775	3.62	2730	2.73	1356	1.51	219	1.53	227	1.40	180	1.54	231	1.76	330	2.48	1004	2.12	580
28	2.56	1111	6.03	6396	3.30	2240	3.25	2162	2.56	1111	1.53	227	1.43	190	1.40	180	1.44	194	1.71	305	2.48	1004	2.31	792
29	2.40	900	....	....	3.07	1883	3.00	1775	2.54	1084	1.53	227	1.40	180	1.38	173	1.42	187	1.91	417	3.06	1868	2.83	1511
30	2.19	650	....	....	2.87	1573	2.82	1496	2.62	1194	1.50	215	1.44	194	1.34	162	1.40	180	1.67	286	2.80	1465	4.88	4644
31	2.08	544	....	....	2.62	1194	....	....	2.69	1295	....	....	1.43	190	1.33	159	....	...	1.48	208	....	....	3.98	3275

a. Max. 7.0 = 7975 sec.-ft.

Daily Gage Heights and Discharges of Tionesta Creek at Nebraska, Pa., for 1911.

Day	January		February		March		April		May		June		July		August		September	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.44	2441	3.12	1961	1.85	380	2.65	1237	2.35	840	1.25	137	1.27	143	0.85	53	2.10	560
2	3.61	2715	2.88	1464	2.06	528	2.50	1030	3.00	1775	1.22	130	1.22	130	0.84	51	1.90	410
3	4.98	4799	2.66	1252	1.98	466	2.35	840	2.60	1165	1.15	112	1.20	125	0.94	68	1.78	340
4	4.14	3522	2.95	1692	1.83	368	2.35	840	2.45	965	1.15	112	1.08	96	1.32	156	1.52	223
5	3.53	2595	2.70	1310	1.94	438	3.30	2240	2.30	780	1.15	112	1.03	85	1.33	159	1.46	206
6	3.30	2240	2.26	732	1.80	350	3.70	2850	2.16	620	1.23	132	1.00	79	1.32	156	4.05	3377
7	3.18	2054	2.44	952	1.45	197	4.40	3915	2.20	660	1.17	118	1.00	79	1.30	150	3.00	1775
8	2.90	1620	2.30	780	1.85	380	3.70	2850	2.00	480	1.12	105	0.95	70	1.26	140	2.46	978
9	2.96	1713	2.16	620	1.75	325	3.50	2550	1.93	431	1.08	96	0.94	68	1.20	125	4.30	3765
10	2.60	1165	2.03	504	1.98	466	3.22	2116	1.90	410	1.07	94	0.92	65	1.06	92	3.30	2240
11	2.68	1279	1.84	374	2.15	610	3.00	1775	1.92	424	1.04	87	0.83	50	0.96	71	2.80	3000
12	4.53	1076	1.96	452	2.30	780	2.90	1620	1.75	325	2.47	991	0.87	56	0.92	65	2.43	939
13	4.98	4799	1.03	85	2.57	1124	2.70	1310	1.70	300	2.42	926	0.83	50	0.90	61	2.15	610
14	a 6.08	6474	1.04	87	2.56	1117	3.20	2085	1.63	268	1.92	424	0.85	53	0.87	56	2.00	480
15	6.48	7084	3.22	2116	2.50	1030	3.65	2775	1.60	255	1.63	268	0.83	50	0.98	75	4.50	4065
16	4.80	4520	2.65	1237	2.18	640	3.25	2157	1.55	235	1.27	143	0.83	50	1.65	277	4.90	4675
17	3.84	3062	2.60	1165	2.20	660	3.05	1847	1.65	277	1.32	156	0.85	53	1.45	197	3.00	1775
18	3.15	2002	4.11	3475	2.52	1057	2.80	1465	1.58	247	1.27	143	0.93	66	1.32	156	2.85	1542
19	3.00	1775	3.44	2457	2.35	840	2.65	1237	1.70	300	1.22	130	0.94	68	1.20	125	2.50	1030
20	2.66	1252	3.12	1961	2.35	840	2.92	1651	1.58	247	1.17	118	0.95	70	1.09	98	2.32	804
21	2.55	1097	2.85	1537	2.53	1071	3.50	2550	1.50	215	1.10	100	1.05	89	1.03	85	2.00	480
22	2.47	991	2.62	1194	2.60	1165	3.32	2271	1.45	197	1.03	85	0.87	56	0.96	71	1.90	410
23	2.24	708	2.48	1004	3.30	2240	3.30	2240	1.35	165	1.02	83	0.87	56	0.93	66	1.80	350
24	2.00	480	2.35	840	2.87	1573	3.20	2085	1.30	150	1.02	83	1.00	79	0.96	71	1.65	278
25	2.00	480	2.33	816	2.55	1097	2.98	1744	1.18	120	1.32	156	1.05	89	2.07	536	1.60	255
26	1.90	410	2.20	660	2.60	1165	2.74	1372	1.22	130	1.40	180	0.92	65	2.15	610	1.60	255
27	2.67	1267	2.30	780	4.00	3305	2.56	1117	1.20	125	1.91	417	0.92	65	1.78	340	1.64	273
28	6.30	6810	2.10	560	4.05	3377	2.40	900	1.20	125	1.86	386	0.92	65	2.70	1310	1.72	310
29	4.47	4020	....	...	3.45	2467	2.30	780	1.18	120	1.55	235	0.90	61	4.30	3765	3.05	1853
30	4.15	3532	....	...	3.20	2085	2.30	780	1.15	112	1.55	235	0.90	61	2.91	1635	3.10	1930
31	3.50	2550	....	...	2.92	1651	....	...	1.15	112	....	...	0.87	56	2.35	840	....	....

a. Max. during night 7.68 = 9199 sec.-ft.

Estimated Monthly Discharge of Tionesta Creek at Nebraska, Pa.

[Drainage area, 451 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
November	380	79	142	0.333	0.419
December	1189	79	263	0.583	0.672
1910					
January	4365	201	1089	2.415	2.785
February	6396	212	766	1.700	1.770
March	7975	1194	3417	7.580	8.739
April	3305	277	989	2.200	2.455
May	2271	512	1210	2.683	3.093
June	3000	215	820	1.818	2.029
July	1070	180	251	0.556	0.641
August	208	140	164	0.363	0.418
September	340	132	174	0.386	0.431
October	417	145	201	0.446	0.514
November	1138	251	624	1.384	1.544
December	4644	368	965	2.139	2.466
The year	7975	132	891	1.973	26.885
1911					
January	9199	410	2598	5.760	6.641
February	3475	85	1145	2.539	2.644
March	3305	197	1749	3.878	4.471
April	3915	780	1807	4.007	4.471
May	1775	112	406	0.900	1.038
June	991	83	216	0.479	0.534
July	143	50	72	0.159	0.183
August	3765	51	376	0.834	0.962
September	4675	206	1306	2.896	3.231

BROKENSTRAW CREEK AT YOUNGSVILLE, PA.

This station, situated on the steel highway and trolley bridge, at Youngsville, Warren County, Pa., 3 miles above the mouth of the creek, was established October 22, 1909, by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh.

A staff gage, 14 feet long, is bolted to the downstream side of the right abutment. The zero of this gage is 17.85 feet lower than a point on the top of downstream handrail, 2.7 feet to the right of the third post in handrail from left bank.

Measurements are taken, at ordinary stages, from the downstream side of the bridge; at low stages, by wading. The initial point for soundings is at the top edge of the bridge seat, right abutment.

The channel curves to the right, looking upstream from the station, and there is a riffle 300 feet above the bridge. Below the bridge the channel is straight for 1,000 feet, a riffle occurring 400 feet below the bridge. The bed of the creek is of clay and gravel and fairly permanent. The channel is deep and quiet and the flow during low-stages is mostly at the right side. The right bank is high and does not overflow. The left bank overflows at high stages. The greatest range of gage heights is about 12 feet.

The gage is read daily by W. F. Schnell.

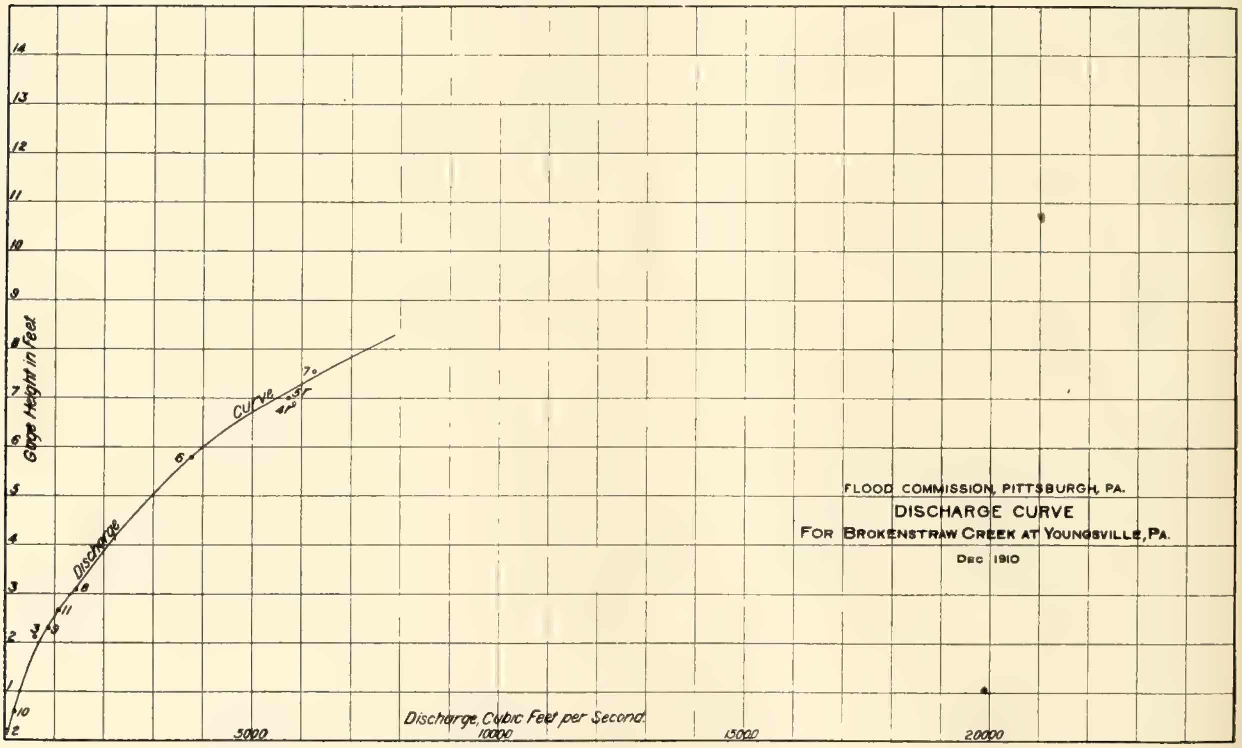
The drainage area above the station is 290 square miles.

Discharge Measurements of Brokenstraw Creek at Youngsville, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1908							
Sept.	28a	Farley Gannett	77	68	0.66	0.20	45
1910							
Jan.	31	K. C. Grant	116	520	1.25	2.00	648
Mar.	1b	H. O. Wheelock	148	1111	5.27	6.90	5850
Mar.	3b	do	148	1131	5.07	7.00	5730
Mar.	5	do	145	961	3.92	5.80	3770
Mar.	7c	do	150	1227	5.10	7.55	6264
Mar.	10	do	107	629	2.27	3.10	1424
Mar.	15	do	100	522	1.65	2.30	857
July	13a	C. E. Ryder	88	101	2.14	0.60	193
Nov.	28	F. E. Langenheim	104	559	1.92	2.65	1073
1911							
June	19	H. P. Drake	85	304	0.36	0.29	108

a. Wading measurement near mouth. c. Falling stage.
b. Rising stage.

PLATE 105



Rating Table for Brokenstraw Creek at Youngsville, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.00	30	1.70	544	3.40	1630	5.10	3055	6.80	5140
.10	52	.80	584	.50	1705	.20	3150	.90	5315
.20	76	.90	626	.60	1780	.30	3245	7.00	5490
.30	102	2.00	672	.70	1855	.40	3345	.10	5665
.40	128	.10	724	.80	1935	.50	3445	.20	5845
.50	155	.20	780	.90	2015	.60	3550	.30	6025
.60	182	.30	844	4.00	2095	.70	3655	.40	6205
.70	210	.40	910	.10	2175	.80	3760	.50	6385
.80	240	.50	980	.20	2260	.90	3870	.60	6565
.90	270	.60	1050	.30	2345	6.00	3985	.70	6745
1.00	300	.70	1120	.40	2430	.10	4105	.80	6925
.10	332	.80	1190	.50	2515	.20	4235	.90	7105
.20	364	.90	1260	.60	2605	.30	4375	8.00	7285
.30	397	3.00	1330	.70	2695	.40	4515	....	....
.40	432	.10	1405	.80	2785	.50	4660	....	....
.50	468	.20	1480	.90	2875	.60	4810	....	....
.60	506	.30	1555	5.00	2965	.70	4970	....	....

Daily Gage Heights and Discharges of Brokenstraw Creek at Youngsville, Pa., for 1909.

Day	November		December		Day	November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.35	115	0.60	182	17	0.75	225	1.80	584
2	0.35	115	0.50	155	18	1.00	300	1.80	584
3	0.40	128	0.50	155	19	1.00	300	1.00	300
4	0.40	128	0.50	155	20	1.00	300	1.00	300
5	0.40	128	0.50	155	21	1.35	415	1.00	300
6	0.40	128	0.50	155	22	1.90	626	1.00	300
7	0.35	115	0.45	141	23	2.20	780	1.00	300
8	0.38	122	0.45	141	24	2.10	724	1.00	300
9	0.75	225	0.45	141	25	1.20	364	1.00	300
10	0.80	240	0.45	141	26	1.00	300	1.00	300
11	0.65	196	0.45	141	27	0.80	240	1.00	300
12	0.50	155	0.45	141	28	0.70	210	1.00	300
13	0.50	155	0.50	155	29	0.70	210	1.00	300
14	0.45	141	2.30	844	30	0.65	196	1.00	300
15	0.40	128	2.10	724	31	....	....	1.00	300
16	0.45	141	2.10	724					

Daily Gage Heights and Discharges of Brokenstraw Creek at Youngsville, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.80	240	1.90	626	7.15	5755	1.20	364	1.30	397	1.40	432
2	0.90	270	1.85	605	7.90	7105	1.10	332	3.20	1480	1.60	506
3	1.30	397	1.80	584	7.10	5665	1.00	300	3.80	1935	2.75	1155
4	1.30	397	1.70	544	6.00	3985	1.15	348	4.25	2302	2.50	980
5	1.30	397	1.70	544	6.10	4105	1.45	450	3.40	1630	1.85	605
6	1.30	397	1.70	544	6.15	4170	1.35	414	2.15	752	1.50	468
7	1.30	397	1.70	544	7.30	6025	1.20	364	1.70	544	1.40	432
8	1.30	397	1.40	432	5.95	3928	1.10	332	1.40	432	1.25	380
9	1.30	397	1.30	397	4.50	2515	1.10	332	1.30	397	1.10	332
10	1.30	397	1.30	397	3.20	1480	1.10	332	1.20	364	1.10	332
11	1.30	397	1.30	397	2.80	1190	0.90	270	1.10	332	1.35	414
12	1.30	397	1.30	397	2.80	1190	0.90	270	0.95	285	2.05	698
13	1.30	397	1.30	397	2.95	1295	0.90	270	0.90	270	1.80	584
14	1.30	397	1.30	397	2.70	1120	0.85	255	0.85	255	1.25	380
15	1.30	397	1.30	397	2.40	910	0.80	240	0.85	255	1.00	300
16	1.30	397	1.50	468	2.30	845	0.90	270	0.80	240	0.85	255
17	1.30	397	2.00	672	2.30	845	0.90	270.	0.70	210	0.80	240
18	3.50	1705	2.00	672	2.10	724	0.90	270	1.05	316	0.75	225
19	5.10	3055	2.00	672	2.10	724	1.10	332	0.95	285	0.70	210
20	4.70	2695	2.00	672	4.00	2095	1.45	450	0.80	240	0.65	196
21	4.50	2515	2.00	672	4.35	2388	1.65	525	0.80	240	0.50	155
22	4.20	2260	2.00	672	3.95	2055	1.65	525	0.75	225	0.50	155
23	2.80	1190	2.00	672	3.50	1705	1.55	487	1.50	468	0.50	155
24	2.50	980	2.00	672	3.20	1480	1.40	432	1.15	348	0.50	155
25	2.00	672	2.00	672	3.20	1480	2.25	812	1.30	397	0.50	155
26	2.00	672	1.80	584	2.80	1190	3.10	1405	1.30	397	0.50	155
27	2.50	980	2.15	752	2.15	752	2.65	1085	1.10	332	0.50	155
28	2.50	980	a 6.80	5140	1.85	605	2.00	672	0.90	270	0.45	142
29	2.50	980	....	....	1.60	506	1.60	506	1.30	397	0.45	142
30	2.20	780	....	....	1.45	450	1.40	432	1.15	348	0.45	142
31	2.00	672	....	....	1.30	397	....	...	1.20	364	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.45	142	0.30	102	0.20	76	0.60	182	2.80	1190	2.45	945
2	0.45	142	0.30	102	0.20	76	0.55	177	3.75	1895	2.30	844
3	0.45	142	0.30	102	0.45	142	0.50	155	4.35	2388	2.15	752
4	0.35	115	0.30	102	0.50	155	0.50	155	3.90	2015	2.10	724
5	0.30	102	0.30	102	0.60	182	0.50	155	2.30	844	1.95	649
6	0.25	89	0.30	102	2.80	1190	1.30	397	1.85	605	1.80	584
7	0.45	142	0.30	102	2.20	780	2.30	844	1.75	564	1.80	584
8	0.50	155	0.30	102	1.50	468	2.10	724	1.75	564	1.80	584
9	0.45	142	0.30	102	1.30	397	1.30	397	1.90	626	1.80	584
10	0.40	128	0.60	182	1.30	397	1.10	332	3.70	1855	1.70	544
11	0.40	128	0.45	142	1.30	397	0.90	270	5.65	3600	1.70	544
12	0.45	142	0.35	115	1.00	300	0.80	240	5.25	3190	1.70	544
13	0.65	196	0.30	102	0.90	270	0.75	225	3.60	1780	1.70	544
14	0.50	155	0.30	102	0.85	255	0.70	210	2.95	1295	1.70	544
15	0.50	155	0.30	102	0.85	255	0.70	210	2.65	1085	1.70	544
16	0.45	142	0.25	89	0.85	255	0.70	210	2.55	1015	1.70	544
17	0.40	128	0.20	76	0.80	240	0.65	196	2.40	910	1.70	544
18	0.40	128	0.20	76	0.80	240	0.60	182	2.30	844	1.70	544
19	0.40	128	0.20	76	0.75	225	0.60	182	2.20	780	1.70	544
20	0.40	128	0.20	76	0.70	210	0.60	182	2.20	780	1.60	506
21	0.35	115	0.20	76	0.60	182	0.60	182	2.10	724	1.60	506
22	0.30	102	0.20	76	0.40	128	0.70	210	2.00	672	1.60	506
23	0.30	102	0.20	76	0.50	155	1.40	432	1.90	626	1.60	506
24	0.55	177	0.20	76	0.70	210	1.30	397	2.95	1295	1.60	506
25	0.50	155	0.20	76	1.00	300	1.40	432	3.95	2055	1.60	506
26	0.45	142	0.20	76	0.90	270	1.70	544	4.00	2095	1.60	506
27	0.40	128	0.20	76	0.80	240	1.90	626	3.20	1480	1.60	506
28	0.40	128	0.20	76	0.70	210	2.30	844	2.95	1295	1.65	525
29	0.40	128	0.20	76	0.65	196	2.50	980	2.90	1260	3.75	1895
30	0.40	128	0.20	76	0.60	182	2.70	1120	2.80	1190	4.95	2920
31	0.35	115	0.20	76	....	...	2.70	1120	....	....	4.60	2605

a. Max 5 P. M., 7.1 = 5665 sec.-ft.

Daily Gage Heights and Discharges of Brokenstraw Creek at Youngsville, Pa., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.70	1855	2.30	844	1.80	584	2.20	780	2.00	672	0.40	128	0.20	76	0.00	30
2	4.55	2560	2.10	724	1.45	450	2.00	672	3.00	1330	0.40	128	0.20	76	0.00	30
3	5.75	3705	1.70	544	1.40	432	1.90	626	2.60	1050	0.40	128	0.20	76	0.50	155
4	5.00	2965	2.00	672	1.30	397	2.05	698	2.00	672	0.40	128	0.20	76	0.40	128
5	3.50	1705	1.60	506	1.30	397	4.45	2475	1.80	584	0.70	210	0.20	76	0.40	128
6	2.60	1050	1.40	432	1.25	380	4.80	2785	1.55	487	0.70	210	0.20	76	0.40	128
7	2.30	844	1.30	397	1.00	300	4.60	2605	1.35	414	0.70	210	0.20	76	0.25	89
8	2.10	724	1.30	397	1.00	300	3.60	1780	1.15	348	0.65	196	0.20	76	0.20	76
9	2.20	780	1.20	364	1.20	364	2.90	1260	1.10	332	0.60	182	0.15	64	0.15	64
10	2.10	724	1.10	332	2.30	844	2.45	945	1.10	332	0.55	168	0.15	64	0.10	52
11	2.20	780	1.10	332	3.05	1365	2.25	812	1.00	300	0.55	168	0.10	52	0.05	41
12	5.75	3705	1.00	300	3.40	1630	2.15	752	1.00	300	0.85	255	0.10	52	0.00	30
13	6.30	4375	0.90	270	3.50	1705	1.95	649	0.95	285	0.80	240	0.10	52	0.00	30
14	6.55	4735	1.80	584	3.75	1895	2.10	724	0.85	255	0.70	210	0.10	52	0.00	30
15	6.70	4970	4.20	2260	2.50	980	2.25	812	0.80	240	0.60	182	0.10	52	0.40	128
16	4.75	2740	3.75	1895	1.90	626	2.05	698	0.80	240	0.50	155	0.10	52	0.75	225
17	3.30	1555	4.05	2135	1.80	584	1.80	584	0.80	240	0.50	155	0.10	52	0.95	285
18	2.40	910	5.00	2965	1.90	626	1.60	506	0.80	240	0.40	128	0.10	52	0.65	196
19	2.25	812	5.05	3010	1.90	626	1.40	432	0.80	240	0.25	89	0.10	52	0.55	168
20	1.95	649	3.10	1405	1.90	626	4.20	2260	0.80	240	0.20	76	0.05	41	0.35	115
21	2.30	844	2.50	980	1.90	626	3.65	1820	0.75	225	0.15	64	0.05	41	0.20	76
22	2.30	844	2.35	877	3.10	1405	2.70	1120	0.70	210	0.10	52	0.05	41	0.10	52
23	1.50	468	1.75	574	3.45	1670	2.45	945	0.70	210	0.10	52	0.05	41	0.00	30
24	1.75	564	1.90	626	3.00	1330	2.25	812	0.70	210	0.10	52	0.05	41	0.05	41
25	1.70	544	1.85	605	2.20	780	1.90	626	0.70	210	0.25	89	0.05	41	0.75	225
26	1.40	432	1.70	544	2.30	397	1.75	564	0.60	182	0.45	141	0.05	41	0.50	155
27	3.55	1745	2.30	844	2.80	584	1.55	487	0.50	155	0.60	182	0.05	41	0.35	115
28	8.25	7735	2.00	672	4.35	2385	1.40	432	0.50	155	0.65	196	0.00	30	3.90	2015
29	5.05	3010	....	....	3.70	1855	1.25	380	0.45	141	0.45	141	0.00	30	6.00	3985
30	4.20	2260	....	....	2.65	1085	1.40	432	0.45	141	0.25	89	0.00	30	5.50	3445
31	2.90	1260	....	....	2.50	980	....	....	0.45	141	....	....	0.00	30	3.00	1330

Estimated Monthly Discharge of Brokenstraw Creek at Youngsville, Pa.

[Drainage area, 290 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
November	780	115	252	0.874	0.975
December	844	141	301	1.038	1.189
1910					
January	3055	240	859	2.962	3.415
February	5665	397	721	2.486	2.589
March	7105	397	2215	7.638	8.806
April	1405	240	445	1.534	1.711
May	2302	210	540	1.862	2.146
June	1155	142	354	1.221	1.362
July	196	89	134	0.462	0.533
August	182	76	93	0.321	0.370
September	1190	76	286	0.986	1.100
October	1120	155	436	1.503	1.732
November	3600	564	1350	4.655	5.193
December	2920	506	764	2.634	3.037
The year	7105	76	683	2.355	31.994

Estimated Monthly Discharge of Brokenstraw Creek at Youngsville, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1911					
January	4970	468	1995	6.810	7.851
February	3010	270	932	3.214	3.375
March	2385	300	910	3.138	3.618
April	2785	380	1016	3.503	3.908
May	1330	141	347	1.197	1.380
June	255	52	141	0.486	0.542
July	76	30	53	0.183	0.211
August	3985	30	227	0.783	0.903

CONEWANGO CREEK AT FREWSBURG, N. Y.

This station, situated at Whitman's Bridge, one mile above Frewsburg, Chautauqua County, N. Y., was established by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh, October 25, 1909.

A standard chain gage, measuring 22.81 feet from marker to bottom of weight, is fastened to the railroad ties, near left abutment of the railroad bridge. The elevation of the outer downstream corner of coping stone of left abutment of railroad bridge is 20.02 feet above the zero of the gage. The distance from the top of downstream track stringer directly under the pulley to the water surface when the gage reads zero, is 21.69 feet.

Measurements are taken from the downstream side of the highway bridge, at ordinary stages, and from the nearby railroad bridge at high stages.

The channel is straight for 75 feet above the station, and then bends to the left. The channel below the station is straight for a distance of 600 feet. The bed of the creek is composed of clay and gravel and may be somewhat shifting. The right bank consists of low, wide meadows, overflowing at high stages. The railroad embankment prevents overflow on the left bank. The greatest range of gage heights is about 15 feet

The gage is read daily by Harold Hobart.

The drainage area above the station is 550 square miles.

All estimates of discharge at this station are based on a provisional discharge curve and should be used with caution.

Discharge Measurements of Conewango Creek at Frewsburg, N. Y.

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1910		*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Mar. 7	H. O. Wheelock	.....	2993	3.18	14.21	9517
Mar. 9	do	.....	2850	3.17	13.76	9046
Mar. 11	do	.....	2458	2.54	12.26	6236
Mar. 14	do	.....	1403	1.99	8.76	3415
Mar. 19	do	.....	1403	1.73	6.66	2426
July 11	do	.....	649	0.32	1.09	208
Nov. 1	H. P. Drake	142	1223	0.96	5.36	1174
Nov. 26	F. E. Langenheim	158	1658	1.59	8.43	2630
1911						
June 18	H. P. Drake	.....	698	0.43	1.31	302

Note. Daily gage heights and discharges of Conewango Creek for 1909 will be found on page 203.

Daily Gage Heights and Discharges of Conewango Creek at Frewsburg, N. Y., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.30	442	a6.11	1417	c13.22	7834	4.53	921	3.48	674	3.23	619	1.56	319	1.04	235	1.27	272	1.23	267	5.47	1190	7.01	1805
2	2.33	447	a5.71	1271	c13.96	9217	4.20	838	6.00	1375	3.48	674	1.46	303	0.98	226	1.32	280	1.23	267	6.07	1402	7.80	2213
3	3.33	641	a5.38	1162	14.58	10426	3.98	785	9.12	3045	4.88	1016	1.50	309	1.02	231	1.52	312	1.25	269	5.73	1278	7.06	1829
4	3.86	758	a5.06	1067	d14.58	10426	3.83	751	9.15	3066	4.97	1040	1.43	298	1.05	237	1.68	338	1.23	267	5.49	1197	6.16	1436
5	3.45	667	a5.09	1075	14.14	9568	3.88	762	7.85	2242	4.08	809	1.28	274	1.02	231	1.78	354	e1.66	335	5.20	1107	5.13	1087
6	3.28	629	a4.74	978	13.86	8983	3.86	758	5.20	1107	3.50	678	1.06	239	0.99	228	5.42	1174	e2.09	405	3.23	619	4.97	1042
7	3.28	629	a4.36	878	14.28	9841	3.77	737	4.55	927	4.08	809	1.18	258	0.96	223	5.98	1368	2.53	483	3.07	585	4.69	964
8	a3.00	571	a4.36	878	14.18	9646	3.67	715	4.15	826	4.10	814	1.14	251	0.94	220	4.26	853	3.05	581	3.10	591	4.61	947
9	a3.00	571	a4.37	880	13.66	8639	3.48	674	3.75	733	3.76	735	1.28	274	0.98	226	2.90	553	2.18	421	4.01	792	4.51	917
10	a2.80	534	a4.25	850	13.16	7726	3.36	647	3.55	689	3.03	577	1.23	267	1.08	242	2.38	456	2.03	395	6.96	1781	4.51	917
11	2.87	547	a4.01	792	12.28	6223	3.17	606	3.40	656	4.03	797	1.30	277	1.48	306	1.86	367	1.68	338	9.36	3220	4.61	947
12	2.80	534	a3.96	781	11.18	4899	2.99	569	3.30	634	4.70	967	1.40	293	1.76	351	1.63	330	1.53	314	f10.41	4111	a4.49	911
13	2.78	530	a3.91	769	9.86	3623	2.90	553	3.10	591	4.50	914	1.53	314	1.27	272	1.46	303	1.39	291	10.31	4018	a4.40	888
14	2.74	524	a3.76	735	8.80	2830	2.74	523	2.85	543	3.18	608	1.60	325	1.26	271	1.40	293	1.40	293	9.61	3416	a4.32	857
15	a2.65	505	a3.76	735	7.69	2151	2.62	500	2.65	505	2.76	526	1.46	303	1.18	258	1.32	280	1.33	282	8.41	2706	a4.36	878
16	a2.52	482	3.96	781	7.20	1897	2.68	511	2.45	469	2.33	447	1.38	290	1.06	239	1.23	267	1.25	269	7.21	1902	a4.11	816
17	a2.42	464	5.67	1257	7.14	1868	2.64	504	2.38	456	2.00	390	1.37	288	1.05	237	1.12	248	1.21	263	6.76	1689	a4.01	792
18	2.80	534	5.96	1360	6.76	1689	2.54	486	2.32	446	1.90	373	1.22	264	0.98	226	1.04	235	1.14	251	6.11	1417	a3.91	769
19	10.00	3742	a6.06	1398	6.66	1645	2.54	486	2.38	456	1.78	354	1.24	268	1.04	235	1.01	231	1.19	259	6.61	1622	4.11	816
20	10.62	4313	a5.96	1360	8.96	2936	2.80	534	2.20	424	1.53	314	1.22	264	1.05	237	1.32	280	1.23	267	5.05	1064	4.21	840
21	10.65	4344	a5.81	1306	9.58	3392	3.25	623	2.50	478	1.38	290	1.22	264	1.06	239	1.34	283	1.13	250	4.96	1039	3.97	783
22	10.72	4413	a6.01	1379	10.25	3964	3.86	758	2.10	407	1.40	293	1.24	268	1.06	239	1.34	283	1.31	279	4.68	962	3.92	772
23	10.28	3991	a6.24	1468	10.39	4093	3.54	687	2.35	451	1.34	283	1.20	261	1.04	235	1.30	277	1.68	338	4.57	932	4.00	790
24	a9.42	3265	a5.58	1226	9.62	3424	3.36	647	2.80	534	1.36	287	1.19	259	0.90	214	1.26	271	1.53	314	5.61	1236	3.93	774
25	a8.65	2732	a5.36	1156	8.69	2759	5.20	1107	2.56	489	1.18	258	1.20	261	0.90	214	1.46	303	2.21	426	8.26	2487	3.96	781
26	a7.91	2277	5.10	1078	8.24	2474	6.75	1684	2.65	505	1.53	314	1.20	261	0.86	208	1.46	303	3.16	605	8.30	2511	4.00	790
27	7.82	2224	5.01	1053	7.24	1917	6.06	1398	2.65	505	1.56	319	1.14	251	1.36	287	1.39	291	2.98	567	8.39	2567	3.41	658
28	a8.10	2390	b10.98	4679	6.26	1476	4.96	1037	2.65	505	1.56	319	1.05	237	0.92	217	1.36	287	4.01	792	8.31	2517	3.61	702
29	a7.85	2242	....	....	5.74	1281	3.78	740	2.52	482	1.59	324	1.08	242	0.96	223	1.34	283	5.18	1101	8.59	2694	5.72	1274
30	a7.30	1947	....	....	6.25	1472	3.47	672	2.56	489	1.58	322	1.04	235	0.96	223	1.26	271	5.09	1075	8.74	2791	9.83	3598
31	a6.80	1707	....	....	4.92	1028	....	...	3.12	595	....	...	0.99	228	0.94	220	....	...	5.15	1093	....	....	9.57	3384

a. Measured to top of ice.
b. Max. 3:30 P. M., 11.69 = 5514 sec.-ft.
c. Gorge above and below bridge.
d. Max. 7:30 A. M., 14.71 = 10675 sec.-ft.
e. Interpolated.
f. Max. 11.66 = 5476 sec.-ft.

Daily Gage Heights and Discharges of Conewango Creek at Frewsburg, N. Y., for 1911.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	9.44	3281	10.72	3759	4.57	932	5.07	1070	6.87	1739	1.55	317	1.24	266	0.84	206	8.37	2554
2	9.70	3490	8.47	2617	4.32	868	4.66	956	6.62	1627	1.50	309	1.20	261	0.94	220	4.35	875
3	9.72	3507	6.57	1605	4.07	807	4.32	867	5.57	1223	1.45	301	1.30	277	1.15	253	2.50	478
4	16.45	11523	5.77	1291	3.85	755	4.77	986	5.27	1128	1.44	299	1.41	295	1.58	322	1.95	381
5	11.96	5874	5.26	1125	3.65	711	6.17	1440	a	1000	1.40	293	1.28	274	1.40	293	3.82	749
6	12.35	6324	5.02	1056	3.55	689	9.62	3424	a	920	1.49	307	1.25	269	1.50	309	4.10	814
7	10.64	4334	4.07	807	3.37	649	9.60	3408	a	840	1.45	301	1.25	269	1.55	317	3.90	767
8	8.95	2930	5.97	1364	3.47	671	9.77	3548	a	790	1.50	309	1.20	261	1.51	311	4.90	1022
9	8.91	2903	4.30	863	3.47	671	7.27	1932	a	740	1.45	301	1.20	261	1.45	301	4.49	911
10	8.92	2909	4.32	868	6.07	1403	6.82	1716	a	690	1.50	309	1.18	258	1.27	272	3.62	704
11	9.07	3011	4.27	856	6.42	1541	5.82	1309	a	650	1.35	285	1.09	243	1.10	245	3.17	606
12	11.26	4991	3.77	737	6.42	1541	4.82	1000	a	610	1.50	309	1.00	229	1.16	255	3.14	598
13	11.42	5179	3.67	715	7.68	2146	4.62	945	a	570	1.41	295	0.99	228	1.11	247	3.12	593
14	12.18	6096	5.37	1153	7.27	1932	4.42	893	a	530	1.45	301	1.00	229	1.09	243	4.27	855
15	12.77	7057	6.32	1500	5.87	1357	4.40	888	a	500	1.45	301	0.89	213	1.50	309	3.30	634
16	12.47	6500	7.58	2093	4.97	1042	4.32	868	a	470	1.40	293	0.89	213	1.87	368	3.28	630
17	11.87	5752	8.87	2876	4.58	935	4.17	831	a	440	1.50	309	0.86	208	1.88	370	2.87	547
18	9.57	3384	11.42	5179	4.47	906	3.87	767	2.12	410	1.39	291	0.87	209	1.55	317	2.43	467
19	7.47	2034	7.47	2034	4.27	855	3.62	704	2.04	397	1.37	288	0.86	208	1.44	299	2.09	405
20	7.07	1834	7.07	1834	4.32	867	4.60	940	1.99	388	1.35	285	0.87	209	1.37	288	2.05	398
21	7.12	1858	7.12	1858	5.02	1056	4.57	932	1.94	380	1.33	282	1.00	229	1.28	274	1.95	381
22	7.08	1839	7.08	1838	6.22	1460	4.38	883	1.69	339	1.40	293	1.29	275	1.25	269	1.70	341
23	6.17	1440	6.17	1440	6.07	1402	4.27	855	1.69	339	1.30	277	1.28	274	1.20	261	1.57	320
24	5.57	1223	5.57	1223	5.52	1207	3.67	715	1.64	331	1.20	261	1.10	245	1.23	265	1.45	301
25	4.57	932	4.57	946	4.68	962	3.42	660	1.61	327	1.29	275	0.96	223	1.28	274	1.48	306
26	7.57	2087	5.97	1364	4.37	880	3.22	616	1.59	323	1.30	277	0.89	213	1.55	317	3.35	645
27	10.57	4365	5.97	1364	5.17	1098	3.07	585	1.49	307	1.45	301	0.79	199	1.45	301	3.48	674
28	10.97	4670	5.92	1345	8.47	2617	2.72	519	1.45	301	1.85	365	0.74	192	4.63	948	3.70	722
29	12.78	7073	....	....	7.32	1957	2.87	547	1.41	295	1.51	311	0.79	199	9.75	3531	3.72	726
30	12.67	6900	....	....	6.52	1584	3.07	585	1.11	247	1.38	290	0.77	196	9.60	3408	3.90	767
31	11.72	5553	....	....	5.52	1207	....	...	1.00	229	....	...	0.78	197	8.60	2700	....	...

a. Estimated from Kinzua and Brokenstraw Creeks, and Allegheny River at Red House, N. Y. Gage out; bridge being repaired.

Daily Gage Heights and Discharges of Conewango Creek at Frewsburg, N. Y., for 1909.

Day	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge	Day	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft.		Feet	Sec.-ft.	Feet	Sec.-ft.
1	1.29	275	1.89	372	17	1.59	324	3.27	627
2	1.21	263	1.81	358	18	1.91	375	a2.87	547
3	1.53	314	1.77	352	19	2.07	402	a2.45	469
4	1.36	287	1.77	352	20	2.11	409	a2.07	402
5	1.37	288	1.76	351	21	2.32	446	a2.42	464
6	1.38	290	1.62	328	22	2.91	555	a2.47	473
7	1.43	298	1.77	352	23	3.99	788	a2.47	473
8	1.37	288	1.77	352	24	3.81	746	a2.48	474
9	1.57	320	a1.47	304	25	2.96	564	a2.37	455
10	1.68	338	a1.52	312	26	2.32	446	a2.17	419
11	1.54	315	a1.57	320	27	2.11	409	a2.12	410
12	1.53	314	a1.47	304	28	2.09	405	a2.31	444
13	1.49	308	1.52	312	29	1.91	375	a2.41	462
14	1.51	310	1.57	320	30	1.93	378	a2.25	433
15	1.49	308	b2.79	532	31	....	....	a2.24	429
16	1.49	308	4.00	790					

a. Creek frozen. b. Interpolated.

Note—All estimates of discharge at this station are based on a provisional discharge curve and should be used with caution.

Estimated Monthly Discharge of Conewango Creek at Frewsburg, N. Y.

[Drainage area, 550 square miles.]

Month	Discharge in second-feet Maximum	Minimum	Mean	Run-off Second-feet per square mile	Depth in inches
1909					
November	788	263	381	0.693	0.773
December	790	304	419	0.762	0.878
1910					
January	4413	442	1599	2.907	3.341
February	5514	735	1206	2.193	2.283
March	10675	1028	4818	8.760	10.099
April	1684	486	740	1.346	1.502
May	3066	407	816	1.300	1.499
June	1040	283	549	0.998	1.113
July	325	228	272	0.495	0.571
August	351	208	240	0.436	0.503
September	1368	231	388	0.705	0.787
October	1101	250	431	0.784	0.904
November	5476	585	1848	3.360	3.749
December	3598	658	1161	2.111	2.313
The year	10675	208	1172	25.395	28.669
1911					
January	11523	932	4221	7.675	8.848
February	5179	715	1633	2.969	3.092
March	2617	649	1245	2.264	2.610
April	3548	519	1179	2.144	2.392
May	1739	229	616	1.120	1.291
June	365	261	298	0.542	0.605
July	295	192	229	0.417	0.481
August	3531	206	590	1.073	1.237
September	2554	301	672	1.223	1.364

KINZUA CREEK AT DEWDROP, PA.

This station, situated on the steel highway bridge at Dewdrop, Warren County, Pa., 3 miles from the mouth of Kinzua Creek, was established October 23, 1909, by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh.

A standard chain gage, measuring 12.99 feet from marker to bottom of weight, is fastened to the downstream side of the bridge, near the left bank. The elevation of the northeast corner of the right abutment is 1,253.70. The elevation of the zero of gage is 1,243.13.

Measurements are taken from the downstream side of the bridge. The initial point for soundings is at the top edge of left bridge seat.

The channel is straight for a distance of 300 feet above and 600 feet below the station. The bed of the creek is composed of rock and gravel and is permanent. There is a good velocity at ordinary stages, but an eddy occurs at the right bank at normal stages. Both banks overflow at extremely high water. The greatest range of gage heights is about 11 feet.

The gage is read daily by Gerald Welden.

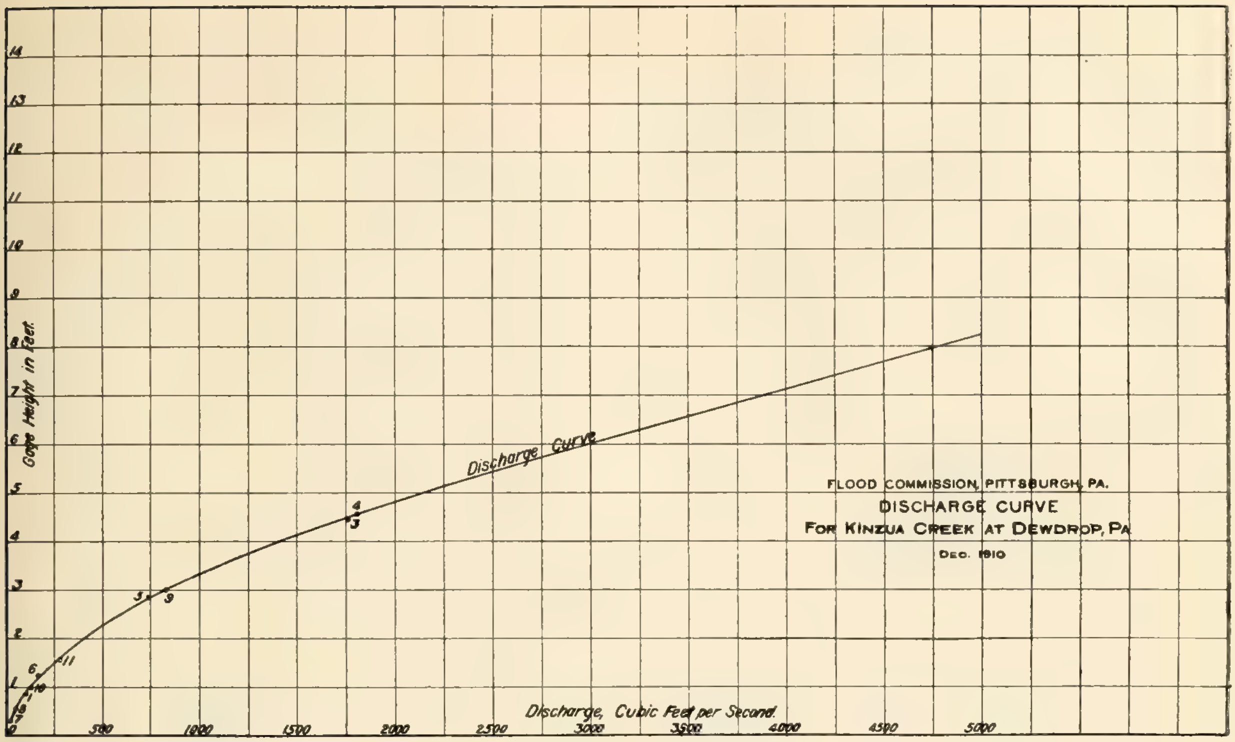
The drainage area above the station is 162 square miles.

Discharge Measurements of Kinzua Creek at Dewdrop, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1909			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Oct.	23	K. C. Grant	92	134	0.76	0.86	102
1910							
Mar.	2	H. O. Wheelock	99	773	3.35	7.30	2584
Mar.	4	do	99	492	3.58	4.46	1762
Mar.	8	do	99	504	3.62	4.56	1814
Mar.	12	do	99	318	2.33	2.84	742
Mar.	28	do	99	329	2.51	3.00	826
June	16	H. P. Drake	99	162	1.04	1.24	164
Aug.	17	do	99	73	0.36	0.30	26
July	11a	C. E. Ryder	..	...	1.70	0.55	50
Nov.	2	H. P. Drake	99	143	0.94	0.98	131
Nov.	27	F. E. Langenheim	99	199	1.38	1.58	275
1911							
June	17	H. P. Drake	96	101	0.70	0.67	71

a. Wading measurement.

PLATE 106



Rating Table for Kinzua Creek at Dewdrop, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.20	20	1.80	344	3.40	1040	5.00	2150	6.60	3524
.30	26	.90	376	.50	1100	.10	2228	.70	3612
.40	34	2.00	410	.60	1160	.20	2308	.80	3700
.50	45	.10	444	.70	1220	.30	2390	.90	3790
.60	58	.20	481	.80	1280	.40	2475	7.00	3880
.70	74	.30	519	.90	1342	.50	2560	.10	3970
.80	92	.40	558	4.00	1408	.60	2645	.20	4060
.90	111	.50	598	.10	1474	.70	2732	.30	4150
1.00	132	.60	640	.20	1544	.80	2820	.40	4240
.10	154	.70	684	.30	1616	.90	2908	.50	4330
.20	177	.80	730	.40	1688	6.00	2996	.60	4420
.30	202	.90	776	.50	1762	.10	3084	.70	4510
.40	228	3.00	824	.60	1838	.20	3172	.80	4600
.50	254	.10	874	.70	1916	.30	3260	.90	4690
.60	283	.20	927	.80	1994	.40	3348	8.00	4780
.70	312	.30	982	.90	2072	.50	3436	....	....

Note. Daily gage heights and discharges of Kinzua Creek for 1909 will be found on page 208.

Daily Gage Heights and Discharges of Kinzua Creek at Dewdrop, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.14	163	1.85	360	a 8.60	3230	2.03	420	2.34	535	1.76	331
2	1.20	177	1.61	286	a 7.59	2650	1.87	366	3.15	900	1.85	360
3	1.36	218	2.39	554	a 6.20	1900	1.74	325	3.13	890	2.57	627
4	1.37	220	2.49	594	4.60	1838	1.73	322	3.23	944	2.17	420
5	1.41	231	2.65	662	4.40	1688	1.90	376	2.83	744	2.05	427
6	1.55	268	2.95	800	4.67	1893	1.73	322	2.60	640	1.97	400
7	1.57	274	2.90	776	6.17	3146	1.65	298	2.40	558	1.87	366
8	1.65	298	2.85	753	5.17	2284	1.55	268	2.23	492	1.77	334
9	1.63	292	2.83	744	3.85	1311	1.49	251	2.07	434	1.63	292
10	1.56	271	2.61	644	3.35	1011	1.43	236	1.93	386	1.55	268
11	1.55	268	2.45	578	3.07	859	1.35	215	1.80	344	1.56	271
12	1.55	268	2.35	538	2.93	790	1.35	215	1.69	309	1.51	257
13	1.55	268	2.35	538	2.83	744	1.25	190	1.59	280	1.40	228
14	1.55	268	2.35	538	2.60	640	1.22	182	1.52	260	1.26	192
15	1.55	268	2.36	542	2.37	546	1.17	170	1.41	231	1.19	175
16	1.55	268	2.39	554	2.35	538	1.43	236	1.33	210	1.17	170
17	1.55	268	2.47	586	2.27	507	1.31	205	1.27	194	1.17	170
18	2.57	627	2.45	578	2.13	455	1.75	328	1.33	210	1.30	202
19	4.85	2033	2.47	586	2.37	546	1.85	360	1.25	190	1.13	161
20	4.50	1762	2.59	636	3.25	954	2.15	462	1.23	185	1.05	143
21	4.35	1652	2.65	662	3.73	1238	2.37	546	1.27	194	0.93	117
22	4.85	2033	2.96	805	3.69	1214	2.31	523	1.17	170	0.87	105
23	4.10	1474	2.96	805	3.70	1220	2.19	477	2.63	653	0.84	100
24	3.75	1250	2.80	730	3.90	1342	2.57	627	1.95	393	0.79	90
25	3.10	874	2.71	689	4.30	1616	3.65	1190	2.23	492	0.75	83
26	2.70	684	2.59	636	3.83	1299	3.37	1022	2.00	410	0.70	74
27	2.80	730	3.33	999	3.25	954	3.03	839	1.87	366	0.69	72
28	2.65	662	a 7.95	2840	2.95	800	2.73	698	1.70	312	0.67	69
29	2.40	558	....	....	2.65	662	2.53	611	1.60	283	0.65	66
30	2.30	519	....	....	2.40	558	2.45	578	1.73	322	0.63	63
31	2.37	546	....	....	2.20	481	....	...	1.70	312	....	..

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.60	58	0.45	39	0.25	23	0.28	25	0.81	94	1.75	328
2	0.59	57	0.39	33	0.26	24	0.27	24	0.91	113	1.68	307
3	0.55	52	0.39	33	0.43	37	0.24	22	1.01	134	1.50	254
4	0.55	52	0.43	37	0.76	84	0.22	21	0.88	107	1.42	233
5	0.51	46	0.35	30	0.72	78	0.25	23	0.78	88	1.34	212
6	0.46	41	0.37	32	0.86	103	0.39	33	0.74	81	1.28	197
7	0.75	83	0.35	30	0.76	84	0.89	109	0.66	67	1.22	182
8	0.75	83	0.31	27	0.58	55	0.56	52	0.70	74	1.28	197
9	0.50	45	0.29	25	0.50	45	0.46	40	0.78	88	1.25	190
10	0.44	40	0.74	81	0.40	34	0.41	35	1.16	168	1.15	165
11	0.50	45	0.79	90	0.33	28	0.37	32	1.70	312	1.25	190
12	0.88	107	0.53	49	0.28	25	0.35	30	1.63	292	1.25	190
13	1.52	260	0.39	33	0.32	27	0.31	27	1.35	215	1.25	190
14	0.90	111	0.35	30	0.33	28	0.28	25	1.29	200	1.45	241
15	0.65	66	0.31	27	0.32	27	0.32	28	1.30	202	1.68	307
16	0.58	55	0.31	27	0.28	25	0.31	27	1.23	185	2.00	410
17	0.62	61	0.33	28	0.27	24	0.30	26	1.19	175	1.92	383
18	0.53	49	0.31	27	0.26	23	0.26	23	1.19	175	1.65	297
19	0.49	44	0.39	33	0.28	25	0.26	23	1.17	170	1.65	297
20	0.44	40	0.37	32	0.28	25	0.26	23	1.13	161	1.62	289
21	0.40	34	0.29	25	0.28	25	0.26	23	1.15	165	1.62	289
22	0.40	34	0.24	22	0.24	22	0.72	78	1.19	175	1.58	277
23	0.40	34	0.24	22	0.20	20	0.78	88	1.15	165	1.52	260
24	0.38	32	0.24	22	0.38	32	0.61	60	1.50	254	1.45	241
25	1.11	156	0.24	22	0.78	88	0.78	88	1.90	376	1.45	241
26	0.75	83	0.58	55	0.66	67	0.94	119	1.80	344	1.50	254
27	0.55	83	0.47	42	0.54	50	0.90	111	1.60	283	1.50	254
28	1.05	143	0.31	27	0.45	40	1.15	165	1.62	289	1.60	283
29	0.64	63	0.29	25	0.38	32	1.04	141	2.10	444	2.96	396
30	0.60	58	0.25	23	0.34	29	0.88	107	1.92	383	4.14	1502
31	0.52	48	0.23	22	....	..	0.86	103	....	...	3.15	900

a. Feb. 28, Max. 10.0, 5:00 P. M.; Mar. 1, Max. 9.5, 8:00 A. M. Gorge formed ¼ mile below station during night of Feb. 27; broke about noon, Mar. 3. Discharge reduced about 40 per cent.

Daily Gage Heights and Discharges of Kinzua Creek at Dewdrop, Pa., for 1911.

Day	January		February		March		April		May		June		July		August		September	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.46	1076	2.86	758	1.41	231	2.16	466	1.96	396	0.91	113	1.08	150	0.16	16	1.02	137
2	3.06	854	2.56	623	1.56	271	2.06	430	2.31	523	0.76	85	0.40	34	0.19	19	0.86	103
3	4.88	2056	2.26	501	1.56	271	1.86	363	1.96	396	0.66	68	0.39	33	0.61	60	0.73	79
4	3.66	1196	2.46	582	1.36	217	1.96	396	1.86	363	0.66	68	0.32	28	1.36	218	0.65	64
5	2.96	795	2.10	444	1.06	145	2.56	623	1.66	300	1.06	145	0.32	28	0.73	79	0.71	76
6	2.86	758	1.86	363	1.36	217	3.36	1017	1.66	300	0.96	123	0.32	28	0.40	34	3.02	834
7	2.66	666	1.96	396	1.26	192	3.16	906	1.56	271	0.86	103	0.38	32	0.44	38	2.15	462
8	2.16	466	1.96	396	1.16	167	3.66	1196	1.46	243	0.86	103	0.34	29	0.48	43	1.82	350
9	2.21	485	1.71	315	1.06	145	3.16	906	1.46	243	0.86	103	0.27	24	0.38	32	2.36	542
10	1.86	363	1.56	271	1.66	300	2.96	805	1.41	231	0.76	85	0.30	26	0.30	26	2.19	477
11	1.96	396	1.36	217	1.66	300	2.76	711	1.46	243	0.71	76	0.44	38	0.23	22	1.90	376
12	3.76	1256	1.26	192	1.76	331	2.48	590	1.36	217	1.56	271	0.30	26	0.19	19	1.57	274
13	3.46	1076	1.36	217	2.16	466	2.46	5582	1.26	192	1.86	363	0.20	20	0.18	18	1.38	223
14	4.26	1587	1.31	205	2.18	474	2.56	623	1.16	167	1.66	300	0.17	17	0.17	17	1.27	170
15	5.41	2483	2.41	562	2.08	436	3.21	933	1.16	167	1.26	192	0.19	19	0.73	79	3.77	1262
16	4.26	1587	1.26	192	2.06	430	2.76	711	1.11	156	1.06	145	0.17	17	0.73	79	2.88	767
17	3.46	1076	1.86	363	1.76	331	2.61	644	1.21	180	0.96	123	0.48	43	0.46	41	2.32	527
18	2.86	758	4.11	1481	1.96	396	2.36	542	1.11	156	1.01	134	0.44	38	0.38	32	1.96	396
19	2.66	666	2.96	795	1.69	309	2.16	466	1.06	145	0.96	123	0.32	28	0.32	28	1.77	335
20	2.36	542	2.66	666	1.76	331	3.36	1017	1.01	134	0.91	113	0.44	38	0.25	23	1.67	300
21	2.20	481	2.26	501	1.86	363	2.86	758	0.96	123	0.91	113	0.44	38	0.21	21	1.60	283
22	2.16	466	2.11	448	1.83	353	2.76	711	0.86	103	0.86	103	0.27	24	0.17	17	1.47	246
23	1.79	341	1.96	396	2.81	735	2.86	758	0.86	103	1.01	134	0.21	21	0.15	15	1.32	207
24	1.56	271	2.08	436	2.16	466	2.56	623	0.91	113	0.96	123	0.30	26	0.21	21	1.25	190
25	1.56	271	1.96	396	2.26	501	2.36	542	0.91	113	1.13	161	0.25	23	0.78	88	1.22	182
26	1.66	300	1.31	205	2.16	466	2.26	501	0.81	94	1.86	363	0.25	23	0.79	90	1.25	190
27	1.76	331	1.91	379	3.56	1136	2.06	430	0.71	76	1.68	298	0.23	22	0.55	51	1.25	190
28	6.41	3357	1.76	331	3.86	1317	1.96	396	0.66	68	1.36	217	0.21	21	1.88	370	1.22	182
29	4.36	1659	....	...	3.26	960	1.86	363	0.66	68	1.14	163	0.19	19	2.65	666	3.75	1250
30	4.16	1516	....	...	2.86	758	1.86	363	0.61	60	1.06	145	0.15	15	1.55	268	2.88	767
31	3.26	960	....	...	2.56	623	....	...	0.55	53	....	...	0.12	13	1.19	175	....	....

Daily Gage Heights and Discharges of Kinzua Creek at Dewdrop, Pa., for 1909.

Day	November		December		Day	November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Height	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.47	42	0.72	78	17	0.68	71	1.03	139
2	0.47	42	0.79	90	18	0.74	81	0.98	128
3	0.48	43	0.73	79	19	0.73	79	1.03	139
4	0.49	44	0.66	68	20	0.72	78	0.98	128
5	0.48	43	0.64	65	21	1.00	132	1.13	161
6	0.46	41	0.64	65	22	1.85	360	1.18	172
7	0.44	38	0.62	61	23	1.75	328	1.18	172
8	0.54	50	0.76	85	24	1.35	215	1.14	163
9	0.95	122	0.87	105	25	1.18	172	1.19	175
10	0.78	88	0.98	128	26	1.05	143	1.26	192
11	0.70	74	0.94	119	27	0.98	128	1.30	202
12	0.62	61	0.84	100	28	0.88	107	1.26	192
13	0.58	55	0.85	102	29	0.86	103	1.24	187
14	0.55	52	2.08	437	30	0.80	92	1.22	182
15	0.54	50	1.33	211	31	...	...	1.20	177
16	0.54	50	1.13	161					

Estimated Monthly Discharge of Kinzua Creek at Dewdrop, Pa.

[Drainage area, 162 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
November	360	38	99	0.579	0.842
December	437	61	144	0.636	0.970
1910					
January	2033	163	635	3.713	4.280
February	2840	286	721	4.216	4.390
March	3230	455	1255	7.339	8.461
April	1190	170	429	2.509	2.799
May	944	170	414	2.421	2.791
June	627	63	223	1.304	1.455
July	260	32	69	0.403	0.465
August	90	22	34	0.199	0.229
September	103	20	41	0.239	0.267
October	165	21	56	0.327	0.377
November	444	67	199	1.164	1.298
December	1502	165	321	1.877	2.164
The year	3230	20	366	2.143	28.976
1911					
January	2483	271	971	5.680	6.548
February	1481	192	451	2.638	2.747
March	1317	145	440	2.573	2.966
April	1196	363	646	3.777	4.214
May	523	53	193	1.129	1.302
June	363	68	155	0.964	1.075
July	150	13	30	0.175	0.195
August	666	15	87	0.509	0.587
September	1262	64	381	2.228	2.486

MONONGAHELA BASIN.

MONONGAHELA RIVER AT LOCK NO. 4, PA.

This station, situated at the Government Dam at Lock No. 4, 41 miles above the mouth, and at the bridge at Belle Vernon, Washington Co., Pa., was established in March, 1905, for the study of flood discharge only.

There are two rod gages, one above and one below the lock. The elevation of the zero of the upper gage is 726.112, while that of the lower is 717.816. The elevation of crest of dam is 734.94.

The discharge at high water is determined by computations of the flow over the crest of the dam, and at low water by current meter measurements from the bridge.

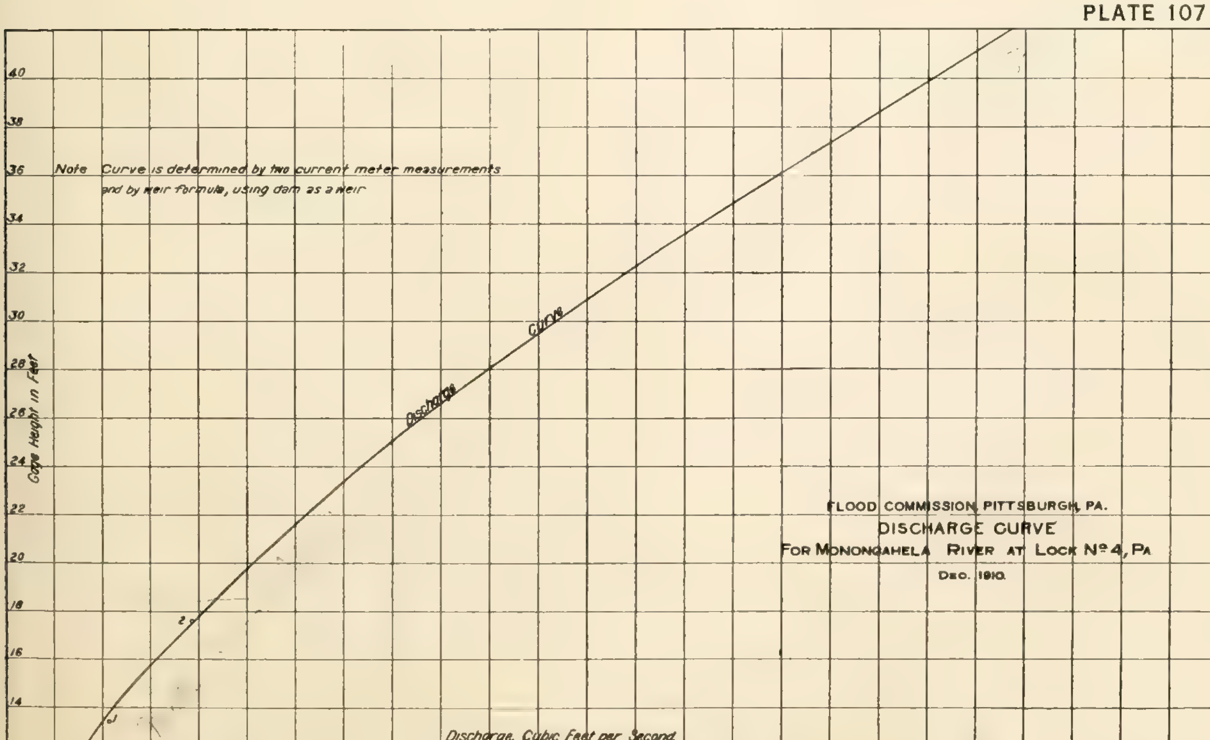
The channel is straight for a distance of 800 feet above and below the bridge. The bed of the stream is composed of sand and gravel, and is permanent. There are three channels under the bridge at all stages and no obstruction to flow. The velocity is low, except at high stages. The greatest range between high and low water is about 35 feet.

The drainage area above the station is 5430 square miles.

Discharge Measurements of Monongahela River at Lock No. 4, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1905			Feet	Sq. ft.	Ft. per sec.	Feet	Sec.-ft.
March	13	E. C. Murphy	866	12210	1.76	13.60	21520
March	18	do	843	10780	0.95	9.80	10240
March	23	Grover and Morse	754	13790	2.80	17.60	38680

PLATE 107



Rating Table for Monongahela River at Lock No. 4, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
12.00	15300	13.60	20880	15.40	28600	18.60	44100	28.00	99600
.10	15600	.70	21280	.60	29500	.80	45100	29.00	106600
.20	15900	.80	21680	.80	30400	19.00	46100	30.00	113600
.30	16210	.90	22080	16.00	31300	.50	48600	31.00	120600
.40	16520	14.00	22500	.20	32200	20.00	51300	32.00	127600
.50	16840	.10	22920	.40	33100	.50	54050	33.00	135000
.60	17160	.20	23340	.60	34100	21.00	56800	34.00	143000
.70	17490	.30	23760	.80	35100	.50	59550	35.00	151000
.80	17830	.40	24180	17.00	36100	22.00	62300	36.00	159000
.90	18180	.50	24600	.20	37100	.50	65050	37.00	167000
13.00	18540	.60	25040	.40	38100	23.00	67800	38.00	175000
.10	18910	.70	25480	.60	39100	.50	70800	39.00	183000
.20	19290	.80	25920	.80	40100	24.00	73800	40.00	191000
.30	19680	.90	26360	18.00	41100	25.00	79800	41.00	199000
.40	20080	15.00	26800	.20	42100	26.00	85800	.....	......
.50	20480	.20	27700	.40	43100	27.00	92600	.....	......

The above table is furnished by the U. S. Geological Survey. It is applicable only to open-channel conditions. It is based on three discharge measurements, besides slope and weir measurements. The gage heights refer to the lower gage. Daily gage heights at this station are published by the U. S. Weather Bureau. The stages during the principal floods will be found in the tables in Chapter III.

TURTLE CREEK AT EAST PITTSBURGH, PA.

This station, situated on the Cable Avenue viaduct from P. R. R. depot to Westinghouse works, was established December 1, 1907, by K. C. Grant, for the Water Supply Commission of Pennsylvania, in connection with studies of the flood conditions in Turtle Creek Valley. The staff gage, 16 feet long, is fastened to the right abutment on the downstream side of the viaduct. The elevation of the zero of the gage is 722.88. The elevation of top of right abutment, downstream corner, is 746.63.

Measurements are taken from the downstream side of the viaduct. The initial point for soundings is on the downstream handrail directly above the top edge of coping of left bridge seat.

The channel above and below the station is straight for about 1000 feet and is walled in for the entire distance. There is a low dam about 200 feet downstream from the station. The bed of the stream is composed of gravel and muddy clay and is somewhat shifting. Both banks are high and do not overflow except in high backwater from the Monongahela. The greatest range between high and low water is x about 11 feet.

The gage is read daily by an employee of the Westinghouse works.

The drainage area above the station is 145 square miles.

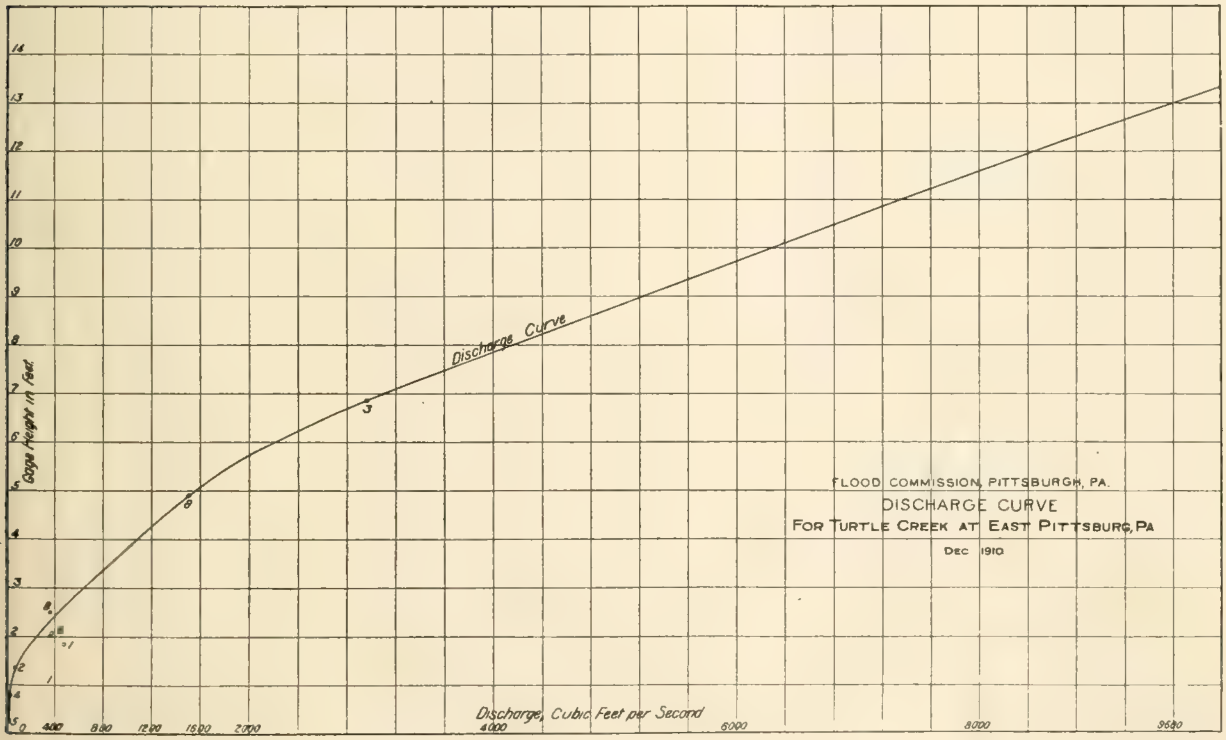
x There is no back water effect from the Monongahela at this point

Discharge Measurements of Turtle Creek at East Pittsburgh, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1907							
Nov.	7	K. C. Grant	84	215	2.22	1.85	477
1908							
Jan.	10	do	67	107	0.54	1.35	58
Feb.	15	Water Supply Commission	87	578	5.07	6.85	2956
Aug.	22	do	54	64	0.42	0.79	27
Sept.	24a	F. E. Langenheim	14	11	1.27	0.25	14
1909							
Mar.	11	K. C. Grant	87	195	1.92	2.07	374
1910							
Jan.	18	Samuel Eckels	..	...	....	10.10	6410
Jan.	29	do	87	177	2.03	2.50	361
Feb.	21	do	87	391	3.86	4.90	1509

a. Wading measurement 300 feet above bridge.

PLATE 108



Rating Table for Turtle Creek at East Pittsburgh, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.20	12	2.40	393	4.60	1365	6.80	2905	9.00	5230
.30	13	.50	432	.70	1415	.90	3000	.10	5335
.40	14	.60	472	.80	1465	7.00	3100	.20	5440
.50	16	.70	512	.90	1515	.10	3200	.30	5545
.60	18	.80	552	5.00	1565	.20	3300	.40	5655
.70	21	.90	592	.10	1615	.30	3405	.50	5765
.80	25	3.00	635	.20	1665	.40	3510	.60	5875
.90	30	.10	679	.30	1720	.50	3615	.70	5985
1.00	36	.20	723	.40	1780	.60	3725	.80	6095
.10	43	.30	767	.50	1840	.70	3835	.90	6200
.20	53	.40	811	.60	1905	.80	3945	10.00	6305
.30	65	.50	855	.70	1975	.90	4055	.10	6410
.40	80	.60	899	.80	2050	8.00	4165	.20	6515
.50	100	.70	943	.90	2125	.10	4270	.30	6620
.60	124	.80	987	6.00	2205	.20	4375	.40	6725
.70	153	.90	1031	.10	2285	.30	4480	.50	6830
.80	185	4.00	1075	.20	2370	.40	4585	.60	6935
.90	217	.10	1120	.30	2455	.50	4690	.70	7040
2.00	250	.20	1167	.40	2540	.60	4795	.80	7145
.10	285	.30	1215	.50	2625	.70	4900	.90	7250
.20	320	.40	1265	.60	2715	.80	5010	11.00	7355
.30	356	.50	1315	.70	2810	.90	5120	.....	.....

Daily Gage Heights and Discharges of Turtle Creek at East Pittsburgh, Pa., for 1907.

Day	December		Day	December		Day	December	
	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge		Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*		*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*
1	1.00	36	12	1.50	100	23	6.25	2412
2	1.00	36	13	1.25	59	24	3.52	864
3	1.00	36	14	1.62	130	25	2.30	356
4	1.00	36	15	1.88	211	26	2.25	338
5	1.25	59	16	2.12	292	27	2.36	378
6	0.75	23	17	1.75	169	28	2.15	302
7	1.00	36	18	1.50	100	29	1.98	243
8	*1.25	59	19	1.50	100	30	2.30	356
9	1.50	100	20	1.25	59	31	2.20	320
10	2.00	250	21	1.62	130			
11	1.75	169	22	1.25	59			

*Interpolated.

Daily Gage Heights and Discharges of Turtle Creek at East Pittsburgh, Pa., for 1908.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.85	201	1.80	185	4.90	1515	2.10	285	....	....	1.45	90
2	1.65	139	1.65	139	4.85	1490	2.05	268	....	....	1.30	65
3	1.60	124	1.40	80	4.20	1167	2.00	250	....	....	1.30	65
4	1.66	141	1.40	80	2.35	375	2.00	250	....	....	1.30	65
5	1.90	217	1.30	65	2.10	285	....	...	....	....	1.30	65
6	1.50	100	1.55	112	4.40	1265	....	...	....	....	1.30	65
7	1.55	112	1.60	124	3.62	908	....	...	4.05	1098	*1.25	59
8	1.60	124	1.50	100	3.15	701	....	...	3.85	1009	1.20	53
9	1.55	112	1.60	124	3.35	789	....	...	2.60	472	1.25	59
10	1.35	73	1.45	90	3.20	723	....	...	*2.20	320	1.15	48
11	1.40	80	1.70	153	2.40	393	....	...	1.80	185	1.25	59
12	2.92	601	2.30	356	2.20	320	....	...	1.70	153	1.20	53
13	2.95	614	3.00	635	2.10	285	....	...	1.70	153	1.20	53
14	2.15	302	3.62	908	2.35	375	....	...	1.65	139	*1.25	59
15	1.85	201	6.70	2810	2.85	572	....	...	2.10	285	1.30	65
16	1.85	201	a 10.40	6725	2.45	413	....	...	1.70	153	1.30	65
17	1.60	124	3.95	1053	2.25	338	....	...	1.75	169	1.20	53
18	1.80	185	2.40	393	4.10	1120	....	...	2.40	393	1.20	53
19	1.95	234	2.00	250	b 6.10	2285	....	...	2.25	338	1.20	53
20	1.45	90	1.95	234	5.05	1590	....	...	2.00	250	1.40	80
21	1.40	80	1.70	153	2.50	432	....	...	1.90	217	*1.30	65
22	1.40	80	1.80	185	2.10	285	....	...	1.85	201	1.25	59
23	1.45	90	1.60	124	2.10	285	....	...	1.80	185	1.70	153
24	1.20	53	1.80	185	2.15	302	....	...	*1.70	153	1.45	90
25	1.30	65	1.85	201	2.00	250	....	...	1.65	139	1.40	80
26	1.85	201	2.45	413	1.85	201	....	...	1.60	124	1.30	65
27	1.85	201	2.05	268	1.80	185	....	...	1.45	90	1.25	59
28	1.50	100	1.80	185	2.00	250	....	...	1.40	80	*1.15	48
29	2.40	393	2.05	268	3.30	767	....	...	1.40	80	1.00	36
30	1.60	124	....	...	2.60	472	....	...	1.60	124	1.00	36
31	1.40	80	....	...	2.40	393	....	...	*1.50	100	....	..

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.90	30	0.70	21	0.60	18	0.75	23	0.80	25	0.70	21
2	0.80	25	*0.65	20	0.55	17	0.75	23	0.65	20	0.75	23
3	0.70	21	0.60	18	0.60	18	0.70	21	0.80	25	0.70	21
4	0.55	17	0.70	21	0.60	18	0.80	25	0.55	17	0.70	21
5	*0.50	16	1.00	36	0.70	21	0.70	21	0.55	17	0.80	25
6	0.50	16	1.40	80	0.70	21	0.60	18	0.65	20	0.75	23
7	0.85	28	1.25	59	0.95	33	0.50	16	0.75	23	1.11	44
8	1.10	43	1.00	36	0.65	20	0.50	16	0.95	33	0.80	25
9	1.00	36	*1.05	40	0.65	20	0.65	20	0.65	20	0.80	25
10	0.90	30	1.10	43	0.70	21	0.65	20	0.75	23	0.75	23
11	0.80	25	1.00	36	0.70	21	0.90	30	0.60	18	0.75	23
12	*0.90	30	1.00	36	0.65	20	0.75	23	0.60	18	0.95	33
13	1.00	36	1.05	40	0.80	25	0.60	18	0.65	20	0.95	33
14	1.10	43	1.15	48	0.85	28	0.60	18	0.65	20	0.70	21
15	1.15	48	1.00	36	0.70	21	0.70	21	0.85	28	0.75	23
16	1.00	36	1.00	36	0.75	23	0.65	20	0.75	23	0.70	21
17	1.20	53	1.15	48	0.75	23	0.70	21	0.80	25	0.80	25
18	1.10	43	1.05	40	0.65	20	0.80	25	0.70	21	1.21	54
19	*1.05	40	0.95	33	0.70	21	0.70	21	0.70	21	1.00	36
20	1.00	36	0.85	28	0.85	28	0.70	21	0.70	21	0.90	30
21	0.90	30	0.80	25	0.60	18	0.65	20	0.75	23	0.70	21
22	0.85	28	1.20	53	0.60	18	0.65	20	0.90	30	0.80	25
23	0.80	25	1.20	53	0.70	21	0.55	17	0.75	23	0.75	23
24	0.90	30	1.20	53	0.40	14	0.80	25	0.60	18	0.75	23
25	1.20	53	1.10	43	0.60	18	0.65	20	0.70	21	0.90	30
26	*1.20	53	1.00	36	0.75	23	0.60	18	0.90	30	0.85	28
27	1.25	59	0.90	30	0.90	30	0.65	20	0.60	18	0.80	25
28	1.10	43	0.85	28	0.80	25	0.70	21	0.70	21	0.70	21
29	0.90	30	0.80	25	0.85	28	0.60	18	0.75	23	0.75	23
30	0.75	23	0.75	23	0.75	23	0.65	20	0.50	16	0.80	25
31	0.70	21	0.75	23	....	..	0.80	25	....	..	0.80	25

a. Max. 1:00 P.M., 10.7 = 7040 sec.-ft. b. Max. 8:30 A.M., 7.4 = 3510 sec.-ft. *Interpolated.

Daily Gage Heights and Discharges of Turtle Creek at East Pittsburgh, Pa., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.80	25	1.05	40	1.74	166	1.42	84	4.76	1445	0.95	33	0.80	25	0.70	21	0.70	21	0.55	17	0.75	23	0.65	20
2	0.70	21	1.05	40	3.84	1005	1.49	98	3.28	758	1.24	58	0.75	23	0.70	21	0.60	18	0.60	18	0.75	23	0.60	18
3	0.80	25	1.05	40	4.43	1280	1.50	100	2.58	464	1.44	88	0.75	23	0.80	25	0.60	18	0.70	21	0.75	23	0.70	21
4	0.90	30	1.05	40	3.33	780	1.42	84	2.52	440	1.28	63	0.75	23	0.80	25	0.70	21	0.50	16	0.70	21	0.75	23
5	1.00	36	1.42	84	2.63	484	1.32	68	2.46	416	2.46	416	0.75	23	0.85	28	0.75	23	0.70	21	0.80	25	0.80	25
6	1.14	47	1.58	119	2.20	320	1.86	204	2.12	292	1.73	163	0.70	21	0.85	28	0.70	21	0.25	13	0.80	25	0.70	21
7	0.90	30	1.50	100	2.36	378	2.63	484	1.90	217	1.31	67	0.60	18	0.75	23	0.60	18	0.60	18	0.80	25	0.95	33
8	0.80	25	1.15	48	1.96	237	1.98	243	1.75	169	1.29	64	0.55	17	0.65	20	0.60	18	0.65	20	0.80	25	0.80	25
9	0.85	28	1.37	76	2.25	338	1.92	224	1.62	130	1.14	47	0.60	18	0.65	20	0.65	20	0.65	20	0.85	28	0.75	23
10	0.95	33	2.20	321	1.94	230	1.88	211	1.65	139	1.14	47	0.60	18	0.70	21	0.65	20	1.17	50	0.85	28	0.60	18
11	0.90	30	1.81	188	2.04	264	1.53	107	1.52	105	1.32	68	0.70	21	0.70	21	0.65	20	1.14	47	0.80	25	0.60	18
12	0.80	25	1.30	65	1.84	198	1.50	100	1.41	82	1.16	49	0.70	21	0.60	18	0.70	21	1.05	40	0.75	23	0.70	21
13	0.65	20	1.83	195	1.89	214	1.52	105	1.38	77	1.10	43	0.70	21	0.70	21	0.55	17	1.05	40	0.75	23	1.26	60
14	0.80	25	1.74	166	1.71	156	3.20	723	1.29	64	1.10	43	0.70	21	0.60	18	0.60	18	0.85	28	0.80	25	1.48	96
15	1.53	107	2.34	371	1.77	175	2.37	382	1.27	61	1.10	43	0.70	21	1.52	105	0.65	20	0.65	20	0.75	23	1.14	47
16	1.44	88	3.60	899	1.63	133	1.98	243	1.27	61	1.05	40	0.70	21	1.16	49	1.11	44	0.70	21	0.85	28	1.00	36
17	1.15	48	2.17	310	1.48	96	1.76	172	1.18	51	1.05	40	0.75	23	1.10	43	0.75	23	0.65	20	0.80	25	0.75	23
18	1.00	36	1.84	198	1.40	80	1.64	136	1.14	47	1.14	47	0.65	20	0.85	28	0.75	23	0.85	28	0.70	21	0.80	25
19	0.75	23	1.69	150	1.56	114	1.55	112	1.11	44	1.00	36	0.80	25	0.75	23	0.65	20	0.80	25	0.65	20	0.80	25
20	1.10	43	2.49	428	1.70	153	1.65	139	1.05	40	0.90	30	0.60	18	1.16	49	0.70	21	0.80	25	0.85	28	0.80	25
21	1.00	36	2.14	299	1.59	122	1.68	147	1.20	53	0.90	30	0.45	15	0.85	28	0.65	20	0.80	25	0.80	25	0.50	16
22	1.37	76	1.92	224	1.46	92	3.39	807	1.10	43	1.00	36	0.55	17	0.75	23	0.55	17	0.75	23	0.65	20	0.60	18
23	1.92	224	3.18	714	1.38	77	2.84	568	1.10	43	0.95	33	1.05	40	0.70	21	0.70	21	1.16	49	0.65	20	0.65	20
24	1.64	136	5.58	1892	1.42	84	2.40	393	1.00	36	0.95	33	0.80	25	0.75	23	0.85	28	1.36	74	0.70	21	0.80	25
25	1.58	119	3.62	908	2.08	278	2.02	257	1.05	40	0.90	30	0.80	25	0.70	21	0.75	23	0.95	33	0.80	25	0.80	25
26	1.36	74	2.85	572	2.08	278	2.12	292	1.05	40	0.90	30	0.80	25	0.75	23	0.75	23	0.85	28	0.70	21	0.80	25
27	1.14	47	2.10	285	2.11	289	2.14	299	1.10	43	0.90	30	0.80	25	0.75	23	0.60	18	0.75	23	0.75	23	0.80	25
28	1.05	40	1.55	112	1.88	211	1.88	211	1.10	43	0.90	30	0.70	21	0.70	21	0.70	21	0.75	23	0.75	23	0.80	25
29	1.43	86	....	...	1.67	144	1.74	166	1.00	36	0.95	33	0.75	23	0.80	25	0.60	18	0.75	23	0.70	21	0.80	25
30	1.32	68	....	...	1.62	130	3.28	758	0.90	30	0.80	25	0.70	21	0.70	21	0.55	17	0.80	25	0.75	23	0.80	25
31	1.05	40	....	...	1.59	122	....	...	0.95	33	....	..	0.65	20	0.70	21	....	..	0.75	23	....	..	0.80	25

Daily Gage Heights and Discharges of Turtle Creek at East Pittsburgh, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.83	26	1.76	172	4.00	1075	1.03	38	1.40	80	0.82	26	0.96	33	0.75	23	0.67	21	0.60	18	0.90	30	1.27	61
2	2.16	306	1.68	147	3.03	648	1.00	36	1.39	79	0.86	28	0.96	33	0.75	23	0.66	20	0.72	22	0.92	31	1.20	53
3	1.97	240	1.66	141	2.81	556	0.98	35	1.27	61	1.02	38	0.88	29	0.75	23	0.66	20	0.70	21	1.24	58	1.20	53
4	4.35	1240	1.65	139	2.50	432	1.00	36	1.27	61	1.14	47	0.84	27	0.74	23	0.71	21	0.68	20	1.20	53	1.44	88
5	1.43	86	1.61	127	2.20	320	1.01	37	1.06	40	1.21	54	0.82	26	0.74	23	1.28	63	0.69	21	1.17	50	1.22	55
6	4.00	1075	1.46	92	1.86	204	0.98	35	1.02	38	0.98	35	0.80	25	0.74	23	1.20	53	0.68	20	1.16	49	1.19	52
7	2.75	532	1.41	82	1.99	247	1.02	37	1.02	38	0.97	34	0.83	26	0.70	21	1.05	40	1.52	105	1.16	49	1.21	54
8	1.08	42	1.40	80	1.78	179	1.01	37	1.02	38	0.98	35	1.49	98	0.46	15	1.50	100	1.40	80	1.12	45	1.20	53
9	1.00	36	1.30	65	1.58	119	0.98	35	1.00	36	0.98	35	1.04	39	0.58	17	1.52	84	1.40	80	1.12	45	1.19	52
10	1.20	53	1.50	100	1.51	102	0.96	33	1.00	36	1.05	40	0.87	28	0.59	18	1.06	40	1.38	76	1.13	43	1.18	51
11	1.15	48	1.30	65	1.46	92	0.93	32	1.02	38	1.22	55	0.86	28	0.66	20	0.93	32	1.37	74	1.14	44	1.25	59
12	1.10	43	1.29	64	1.47	94	0.92	31	1.00	36	1.31	67	0.85	27	0.70	21	0.91	31	1.30	65	1.14	44	1.25	59
13	1.28	63	1.29	64	1.23	57	0.91	31	0.98	35	1.00	36	0.91	31	0.75	23	1.95	233	1.26	60	1.16	49	1.20	53
14	2.85	572	1.16	49	1.46	92	0.90	30	0.99	35	1.00	36	0.89	29	0.75	23	1.38	63	1.29	64	1.20	53	1.20	53
15	2.17	310	1.02	37	1.36	74	0.90	30	1.00	36	1.00	36	0.87	28	0.70	21	1.16	48	1.35	72	1.18	51	1.20	53
16	1.68	147	4.50	1315	1.26	60	0.90	30	0.94	32	0.99	35	0.86	28	0.64	19	0.94	32	1.38	77	1.17	50	1.18	51
17	1.50	100	3.60	899	1.26	60	0.99	35	0.89	29	1.06	40	0.86	28	0.50	16	0.92	31	1.37	76	1.18	51	1.17	50
18	a 9.80	6095	2.14	299	1.26	60	0.91	31	1.15	48	1.12	45	0.85	27	0.62	19	0.77	24	1.30	65	1.18	51	1.25	59
19	6.80	2905	1.72	159	1.20	53	0.94	32	1.10	43	1.70	153	0.85	27	0.70	21	0.76	23	1.20	53	1.18	51	1.30	65
20	2.95	614	2.72	526	1.20	53	1.02	38	1.18	51	b 4.80	80	0.86	28	0.66	20	0.75	23	1.10	43	1.18	51	1.30	65
21	6.10	2285	3.57	886	1.20	53	1.60	124	1.26	60	0.95	33	0.85	27	0.66	20	0.62	19	1.10	43	1.00	36	1.34	71
22	3.85	1009	3.50	855	1.18	51	1.40	80	1.25	59	0.92	31	0.86	28	0.58	18	0.48	16	1.06	40	1.08	39	1.68	147
23	2.37	384	2.48	424	1.16	49	1.60	124	1.21	54	0.90	30	0.85	27	0.60	18	0.42	14	1.00	36	1.14	47	1.67	144
24	2.20	320	2.29	352	1.15	48	1.60	124	1.19	52	0.92	31	0.75	23	0.58	18	0.55	17	1.24	58	1.24	58	3.57	885
25	1.80	185	2.11	289	1.12	45	4.40	1265	1.10	43	0.87	28	0.75	23	0.60	18	1.14	47	1.09	42	1.20	53	2.20	320
26	1.70	153	2.48	424	1.10	43	2.57	460	1.00	36	0.94	32	0.74	23	0.75	23	1.65	138	1.20	53	1.20	53	1.96	237
27	3.70	943	4.65	1390	1.07	41	1.80	185	0.93	32	0.96	33	0.75	23	0.66	20	1.83	26	1.33	61	1.20	53	1.94	230
28	2.60	472	6.50	2625	1.02	37	1.50	100	0.88	29	0.97	34	0.79	25	0.58	18	0.60	18	1.33	61	1.25	48	2.19	317
29	2.16	306	....	....	1.00	36	1.40	80	0.83	23	0.96	33	0.79	25	0.58	18	0.45	15	1.04	39	1.39	79	3.70	512
30	1.85	201	....	....	1.14	47	1.28	63	0.96	33	0.94	32	0.79	25	0.58	18	0.42	14	0.92	31	1.30	65	4.25	1191
31	1.79	182	....	....	1.06	40	....	..	0.96	33	....	..	0.77	24	0.60	18	....	..	0.83	26	....	..	3.21	727

a. Max. at 5 P.M. 11.10 = 7460 sec.-ft. b. Gage height affected by backwater from Monongahela River. Interpolated discharges used.

Estimated Monthly Discharge of Turtle Creek at East Pittsburgh, Pa.

[Drainage area, 145 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
December	2412	23	252	1.738	2.004
1908					
January	614	53	176	1.214	1.400
February	7040	65	572	3.945	4.225
March	3510	185	669	4.614	5.319
June	153	36	64	0.441	0.492
July	59	16	34	0.234	0.270
August	80	18	37	0.255	0.294
September	33	14	22	0.152	0.169
October	30	16	21	0.145	0.167
November	33	16	22	0.152	0.169
December	54	21	26	0.179	0.207
1909					
January	224	20	55	0.379	0.437
February	1892	40	317	2.186	2.276
March	1280	77	278	1.917	2.210
April	807	68	264	1.821	2.032
May	1445	30	179	1.234	1.423
June	416	25	60	0.413	0.461
July	40	15	22	0.152	0.175
August	105	18	28	0.193	0.223
September	44	17	21	0.145	0.162
October	74	13	28	0.193	0.223
November	28	20	24	0.166	0.186
December	96	16	28	0.193	0.223
The year	1892	13	109	0.585	10.031
1910					
January	7460	26	677	4.669	5.383
February	2625	37	424	2.924	3.045
March	1075	36	196	1.352	1.558
April	1265	30	109	0.752	0.839
May	80	29	43	0.291	0.342
June	153	26	42	0.289	0.322
July	98	23	29	0.200	0.231
August	23	15	20	0.131	0.151
September	233	14	44	0.303	0.338
October	105	18	52	0.358	0.413
November	79	30	49	0.338	0.377
December	1191	50	191	1.317	1.518
The year	7460	14	156	1.077	14.517

YOUGHIOGHENY RIVER AT CONNELLSVILLE, PA.

This station, situated on the steel highway bridge at Connellsville, Fayette Co., Pa., 44 miles above the mouth, was established July 22, 1908, by K. C. Grant, for the Water Supply Commission of Pennsylvania. A standard chain gage, the chain of which measures 34.21 feet from bottom of weight to low-water marker and 24.21 from bottom of weight to high-water marker, is bolted to the downstream handrail of the bridge. The elevation of the zero of the gage is 860.131. The elevation of a chiselled point on projecting stone in retaining wall on New Haven side below the bridge, is 864.656.

Measurements are taken from the downstream side of bridge. During extremely low water, measurements are taken by wading at a section 600 feet above B. & O. pumping station, which is situated on the right bank, about one mile above the bridge. The initial point for soundings for the first span is a point on the downstream handrail directly above face of concrete retaining wall along the B. & O. tracks. The initial point for soundings for the second span is the bend in handrail over the channel pier.

The channel above the station is straight for about ½ mile, while below the station there is a straight stretch of about 600 feet. There is a riffle 600 feet upstream from the bridge and another from 600 to 800 feet downstream. The bed of the river is composed of rock, gravel and mud and is fairly permanent. There is a railroad bridge about 500 feet below the station. There is a grist mill on the left bank, the tailrace of which comes in about 100 feet above the bridge. The B. & O. tracks and retaining wall extend along the right bank. Both banks are high and do not overflow. There is a range of about 17 feet between extreme high and extreme low water.

The gage is read daily by C. W. Brooks.

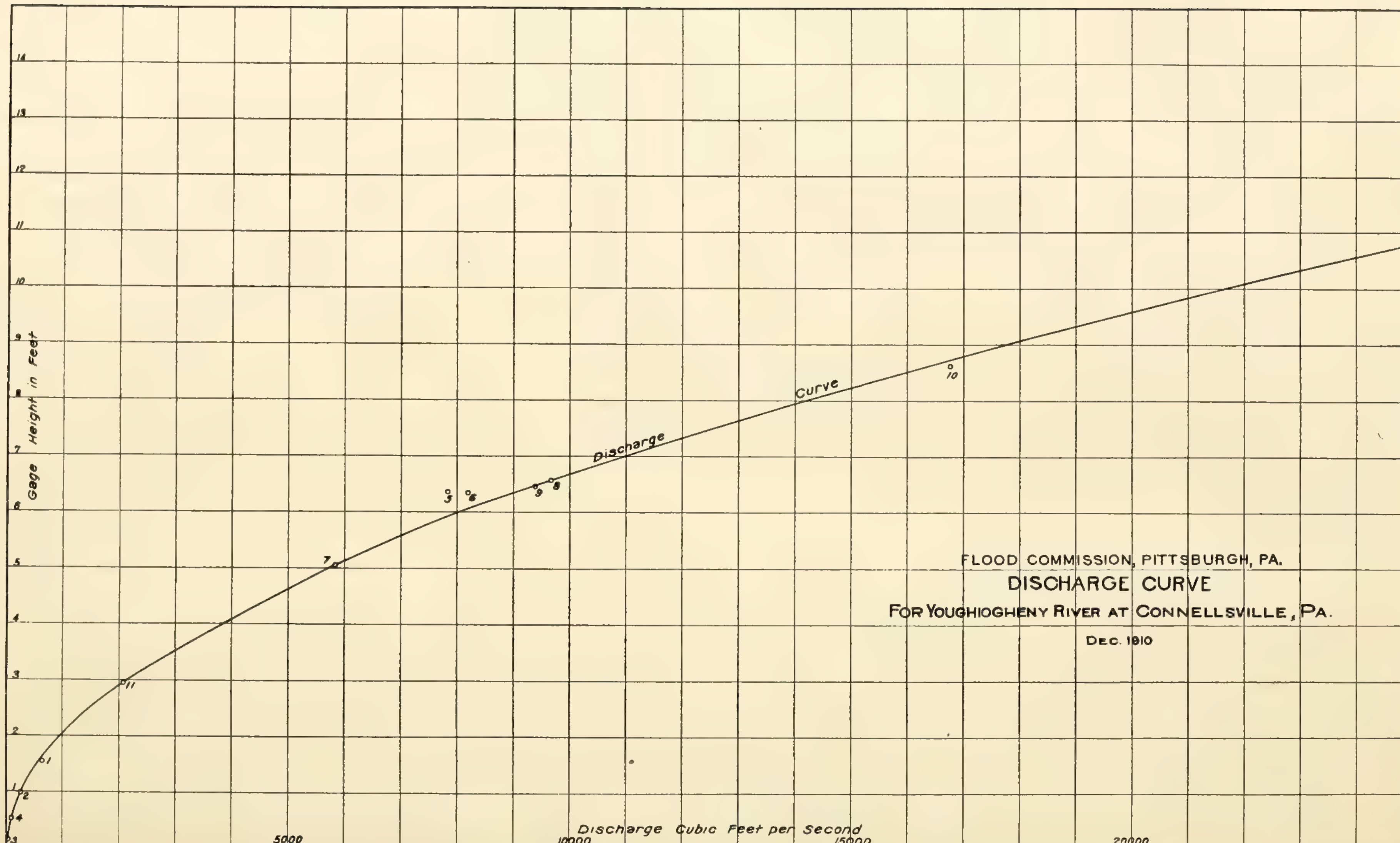
The drainage area above the station is 1320 square miles.

Discharge Measurements of Youghiogheny River at Connellsville, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1908			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
July	22	K. C. Grant	243	812	0.77	1.54	621
Aug.	22	R. H. Bolster	244	674	0.36	0.99	244
Sept.	25a	F. E. Langenheim	14	9	1.67	0.14	16
Nov.	19	K. C. Grant	39	108	0.75	0.51	b83
1909							
Feb.	17	J. D. Stevenson	300	2138	3.65	6.36	7817
Feb.	26	do	303	2121	3.87	6.34	8194
Mar.	9	K. C. Grant	288	1721	3.38	5.06	5824
Apr.	15	F. W. Scheidenhelm	296	2138	4.52	6.57	9657
Apr.	15	do	296	2161	4.43	6.45	9380
1910							
Mar.	1	do	298	2759	6.13	8.71	16756
June	10	do	306	1703	3.58	5.06	6107
June	28	Farley Gannett	260	1192	1.74	2.95	2080
1911							
July	13	F. E. Langenheim	242	831	0.70	1.48	582

a. Wading measurement.

b. Wading measurement above bridge. Discharge of Dunbar Creek, which enters between the wading section and the gage, is included.


FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR YOUGHIOGHENY RIVER AT CONNELLSVILLE, PA.
DEC. 1910
Discharge Curve
Gage Height in Feet
Discharge Cubic Feet per Second
5000
10000
15000
20000

Rating Table for Youghiogheny River at Connellsville, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.10	10	2.40	1360	4.70	5155	7.00	10970	9.30	18890
.20	20	.50	1470	.80	5350	.10	11280	.40	19270
.30	35	.60	1590	.90	5545	.20	11590	.50	19650
.40	55	.70	1715	5.00	5740	.30	11910	.60	20040
.50	75	.80	1855	.10	5950	.40	12230	.70	20440
.60	100	.90	2000	.20	6160	.50	12550	.80	20840
.70	130	3.00	2145	.30	6370	.60	12880	.90	21240
.80	160	.10	2305	.40	6590	.70	13210	10.00	21640
.90	200	.20	2470	.50	6820	.80	13540	.10	22040
1.00	250	.30	2640	.60	7050	.90	13870	.20	22450
.10	300	.40	2810	.70	7280	8.00	14200	.30	22860
.20	350	.50	2980	.80	7520	.10	14530	.40	23270
.30	410	.60	3150	.90	7780	.20	14860	.50	23690
.40	475	.70	3325	6.00	8040	.30	15200	.60	24120
.50	545	.80	3500	.10	8300	.40	15550	.70	24560
.60	615	.90	3680	.20	8580	.50	15920	.80	25000
.70	690	4.00	3860	.30	8860	.60	16290	.90	25440
.80	770	.10	4040	.40	9150	.70	16660	11.00	25880
.90	855	.20	4220	.50	9450	.80	17030	.10	26320
2.00	950	.30	4400	.60	9750	.90	17400	.20	26760
.10	1045	.40	4580	.70	10055	9.00	17770	.30	27200
.20	1145	.50	4770	.80	10260	.10	18140	.40	27640
.30	1250	.60	4960	.90	10665	.20	18510	.50	28100

Daily Gage Heights and Discharges of Youghiogheny River at Connellsville, Pa., for 1908.

Day	July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	...	a1.20	350	0.61	103	0.36	47	0.48	71	0.37	49
2	....	...	0.94	220	0.57	92	0.38	51	0.43	61	0.35	45
3	....	...	0.90	200	0.57	92	0.36	47	0.43	61	0.22	23
4	....	...	0.93	215	0.44	63	0.30	35	0.43	61	0.22	23
5	....	...	0.84	176	0.44	63	0.30	35	0.38	51	0.32	39
6	....	...	0.99	245	0.47	69	0.36	47	0.38	51	0.45	65
7	....	...	0.99	245	0.47	69	0.36	47	0.33	41	0.52	80
8	....	...	1.14	320	0.44	63	0.30	35	0.38	41	0.49	73
9	....	...	1.01	255	0.39	53	0.30	35	0.38	41	0.49	73
10	....	...	0.84	176	0.31	37	0.26	29	0.38	41	0.52	80
11	....	...	0.74	142	0.31	37	0.30	35	0.43	61	0.59	98
12	....	...	0.74	142	0.29	34	0.30	35	0.46	67	0.59	98
13	....	...	0.65	115	0.27	30	0.26	29	0.40	55	0.67	121
14	....	...	0.60	100	0.29	34	0.26	29	0.43	61	0.77	151
15	....	...	0.55	88	0.29	34	0.26	29	0.46	67	0.89	196
16	....	...	0.43	61	0.29	34	0.26	29	0.40	55	0.89	196
17	....	...	0.39	53	0.21	22	0.26	29	0.38	51	1.32	423
18	....	...	1.04	270	0.21	22	0.28	32	0.48	71	2.09	1035
19	....	...	1.71	698	0.17	17	0.26	29	0.53	82	3.12	2338
20	....	...	1.54	573	0.19	19	0.26	29	0.50	75	2.52	1494
21	....	...	0.97	235	0.17	17	0.26	29	0.53	82	1.82	787
22	1.57	594	0.84	176	0.14	14	0.26	29	0.53	82	1.52	559
23	1.42	489	0.87	188	0.11	11	0.28	32	0.58	95	1.27	392
24	1.12	310	0.94	220	0.14	14	0.28	32	0.60	100	0.97	235
25	2.98	2116	1.04	270	0.14	14	0.28	32	0.60	100	1.17	335
26	2.45	1415	0.89	196	0.11	11	0.28	32	0.60	100	1.22	362
27	2.28	1229	0.79	157	0.11	11	0.30	35	0.60	100	1.07	285
28	2.28	1229	0.79	157	0.31	37	0.30	35	0.48	71	0.87	188
29	1.82	787	0.87	188	0.41	57	0.28	32	0.46	67	0.97	235
30	a1.60	615	0.81	164	0.41	57	0.40	55	0.43	61	1.02	260
31	a1.40	475	0.71	133	....	..	0.48	71	....	..	1.02	260

a. Estimated.

Daily Gage Heights and Discharges of Youghiogheny River at Connellsville, Pa., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	0.89	195	1.50	545	4.71	5175	3.60	3150	5.05	5845	2.60	1590	2.01	960	1.29	405	1.50	545	0.78	155	1.57	595	1.23	370
2	0.89	195	1.86	820	4.72	5195	3.79	3480	5.05	5845	3.55	3065	1.93	885	1.24	375	1.25	380	0.69	125	1.45	510	1.21	355
3	1.22	360	2.18	1125	5.46	6730	4.11	4060	4.57	4900	3.46	2910	1.84	805	1.04	270	1.14	320	0.69	125	1.49	540	1.09	295
4	1.57	595	2.18	1125	6.69	10025	4.60	4960	4.53	4825	3.16	2405	1.60	615	0.98	240	1.22	360	0.71	135	1.57	595	1.21	355
5	1.45	510	2.72	1745	5.51	6845	4.91	5565	4.33	4455	3.27	2590	1.41	480	0.88	190	1.56	585	0.67	120	1.54	575	1.28	400
6	1.49	540	4.22	4255	4.92	5585	4.60	4960	3.90	3680	6.41	9180	1.32	425	1.14	320	1.52	560	0.60	100	1.33	430	1.21	355
7	1.67	665	4.05	3950	4.48	4730	4.45	4670	3.56	3080	4.94	5625	1.36	450	0.96	230	1.42	490	0.63	110	1.25	380	1.24	375
8	1.17	335	3.40	2810	5.20	6160	4.05	3950	3.21	2485	4.27	4345	1.30	410	0.84	175	1.23	370	0.55	85	1.22	360	1.54	575
9	1.09	295	3.12	2340	5.05	5845	3.71	3340	2.90	2000	4.27	4345	1.22	360	0.75	145	1.10	300	0.59	100	1.37	455	1.43	495
10	1.55	580	3.62	3185	5.52	6865	3.59	3130	2.93	2045	5.03	5805	1.16	330	0.70	130	1.00	250	0.58	95	1.53	565	1.23	370
11	1.67	665	4.72	5195	5.02	5780	3.33	2690	2.93	2045	6.57	9660	1.09	295	0.64	110	1.01	255	0.79	155	1.65	650	1.07	285
12	1.66	660	3.98	3825	4.36	4510	3.51	2995	2.71	1730	5.43	6660	1.08	290	0.58	95	1.82	785	1.33	430	1.57	590	1.51	550
13	1.57	595	3.84	3570	3.96	3790	3.43	2860	2.43	1395	4.49	4750	1.08	290	0.56	90	1.68	675	2.23	1175	1.47	520	1.75	730
14	1.49	540	4.58	4920	3.76	3430	7.00	10970	2.27	1220	4.05	3950	1.14	320	0.57	90	1.31	415	1.65	655	1.45	510	4.31	4420
15	4.21	4240	4.54	4845	3.54	3050	6.60	9750	2.22	1165	3.79	3485	1.14	320	1.00	250	1.16	330	1.33	430	1.35	440	3.60	3150
16	5.33	6435	5.84	7625	3.21	2485	5.29	6350	2.13	1075	3.77	3445	1.15	325	3.27	2590	1.02	260	1.15	325	1.33	430	2.78	1825
17	3.69	3305	6.22	8635	3.08	2275	4.53	4830	2.06	1005	3.20	2470	1.09	295	4.66	5075	1.19	345	1.07	285	1.31	415	2.10	1045
18	3.09	2290	4.98	5700	2.82	1885	4.04	3930	1.99	940	3.61	3170	1.06	280	3.09	2290	1.64	645	1.15	325	1.27	390	1.87	830
19	2.62	1615	4.30	4400	2.91	2015	3.63	3200	1.89	845	3.35	2725	1.06	280	2.40	1360	1.24	375	1.25	380	1.30	410	1.67	670
20	2.63	1625	4.38	4545	3.66	3255	4.01	3880	1.83	795	2.91	2015	1.02	260	2.05	995	1.16	330	1.31	415	1.28	400	1.43	495
21	2.67	1675	4.39	4560	3.56	3080	6.40	9150	1.83	795	2.58	1565	0.95	225	4.19	4200	1.01	255	1.43	495	1.27	390	1.48	530
22	2.95	2070	4.44	4655	3.22	2505	a8.77	16920	1.96	910	2.44	1405	0.92	210	3.19	2455	0.94	220	1.38	460	1.29	405	1.65	650
23	4.05	3950	4.46	4695	2.97	2100	7.45	12390	2.09	1035	2.56	1540	1.28	400	2.40	1360	0.86	185	1.53	565	1.30	410	1.57	595
24	6.05	8170	a9.04	17920	2.79	1840	6.63	9840	1.95	900	2.61	1600	2.00	950	1.97	920	0.82	170	3.99	3840	1.46	515	1.49	540
25	5.04	5825	8.22	14930	3.04	2210	5.50	6820	1.81	780	2.40	1360	1.56	585	1.70	690	1.04	270	3.90	3680	1.59	610	1.55	580
26	4.07	3985	6.35	9005	3.66	3255	5.19	6140	1.71	700	2.21	1155	1.32	425	1.48	530	1.06	280	2.95	2075	1.52	560	1.52	560
27	3.43	2860	5.70	7280	4.14	4110	4.80	5350	1.84	805	3.37	2760	1.14	320	1.44	505	1.04	270	2.68	1690	1.40	475	1.47	525
28	3.01	2160	5.42	6635	4.32	4435	4.34	4470	2.73	1755	2.75	1785	1.05	275	1.32	425	0.93	215	2.41	1370	1.33	430	1.48	530
29	2.70	1715	....	....	4.25	4310	4.11	4060	2.74	1770	2.67	1680	1.00	250	1.62	630	0.85	180	2.23	1175	1.29	405	1.49	540
30	2.65	1650	....	....	4.01	3880	4.21	4240	2.36	1315	2.57	1555	1.02	260	1.70	690	0.80	160	1.93	885	1.27	390	1.49	540
31	1.93	885	....	....	3.84	3572	....	....	2.21	1155	....	....	1.07	285	1.66	660	....	...	1.71	700	....	...	1.35	440

a. Maximum.

Daily Gage Heights and Discharges of Youghiogheny River at Connellsville, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.39	468	3.19	2455	d 8.83	17140	1.81	780	3.17	2420	3.64	3220	2.15	1095	0.92	210	0.43	61	0.40	55	0.56	90	1.78	754
2	2.48	1448	2.75	1785	8.41	15585	1.75	730	2.86	1945	4.82	5390	1.96	912	0.94	220	0.89	196	0.40	55	0.60	100	1.22	362
3	9.68	20360	3.34	2710	7.23	11685	1.73	715	2.68	1690	4.85	5450	1.90	855	0.86	184	1.12	310	0.29	33	0.62	106	1.27	392
4	9.28	18815	3.38	2775	6.43	9240	1.75	730	2.59	1580	4.34	4470	1.92	874	0.76	148	1.96	912	0.34	43	0.60	100	1.48	531
5	6.21	8610	3.14	2370	6.03	8120	1.83	795	2.42	1380	4.30	4400	1.89	846	0.65	115	1.76	738	0.25	27	0.64	112	1.48	531
6	6.75	10205	2.78	1825	5.97	7960	1.86	805	2.26	1210	5.85	7650	1.74	722	0.60	100	1.61	622	0.23	24	0.53	83	1.34	436
7	8.13	14630	2.36	1315	5.96	7935	1.79	760	2.16	1105	4.90	5545	1.92	874	0.61	103	1.39	469	0.26	29	0.54	85	1.06	280
8	6.12	8355	b 4.29	4380	5.09	5930	1.75	730	2.09	1035	4.14	4110	2.12	1065	0.60	100	1.34	437	0.28	32	0.56	90	1.16	330
9	4.93	5605	b 2.73	1755	4.33	4450	1.73	715	2.23	1175	3.80	3500	1.90	855	0.58	95	1.22	362	0.24	26	0.41	57	1.00	250
10	4.11	4060	b 3.06	2240	3.81	3520	1.65	650	2.32	1270	4.90	5545	1.80	770	0.58	95	1.08	290	0.28	32	0.44	63	1.20	350
11	3.32	2675	b 3.29	2625	3.43	2860	1.56	585	2.80	1855	4.96	5660	1.81	779	0.61	103	0.82	168	0.25	27	0.52	80	1.24	374
12	3.43	2860	b 5.32	6415	3.16	2405	1.49	540	4.11	4060	5.04	5825	1.69	682	0.64	112	0.78	154	0.20	20	0.48	71	1.26	386
13	3.29	2625	b 5.30	* 6370	3.11	2320	1.47	525	3.82	3535	4.50	4770	1.63	636	0.62	106	0.75	145	0.20	20	0.50	75	1.24	374
14	3.21	2485	b 5.40	* 6590	2.91	2015	1.44	505	3.27	2590	3.99	3840	1.80	770	0.57	94	0.98	240	0.18	18	0.52	80	1.20	350
15	3.65	3235	b 5.50	* 6820	2.87	1955	1.42	490	2.95	2075	3.66	3255	1.76	738	0.51	77	0.76	157	0.18	18	0.54	85	1.27	392
16	3.13	2355	5.52	6865	2.61	1600	1.49	540	2.72	1745	3.44	2880	1.77	746	0.54	85	0.75	145	0.18	18	0.60	100	1.24	374
17	3.13	2355	7.17	11495	2.61	1600	1.75	730	2.49	1460	3.94	3750	1.66	660	0.52	80	g 0.85	180	0.16	16	0.64	112	h 1.26	386
18	7.50	12550	6.54	9570	2.53	1505	1.99	940	2.46	1420	3.96	3785	1.58	601	0.47	69	g 0.85	180	0.14	14	0.62	106	1.27	392
19	a 10.28	23780	4.90	5545	2.41	1370	2.63	1630	2.32	1270	f 11.66	28850	1.50	545	0.56	90	g 0.85	180	0.16	16	0.53	83	1.44	503
20	6.83	10450	4.31	4420	2.37	1325	3.09	2290	2.28	1230	7.68	13145	1.31	416	0.70	130	g 0.79	157	0.18	18	0.34	43	1.77	746
21	6.23	8665	4.78	5310	2.63	1630	3.61	3165	2.55	1530	5.60	7050	1.20	350	0.73	139	g 0.77	151	0.16	16	0.35	45	1.82	786
22	* 6.03	8120	c 7.77	13440	2.65	1655	4.07	3985	2.52	1495	4.75	5255	1.10	300	0.59	108	g 0.77	151	0.30	35	0.61	103	1.78	754
23	* 5.83	7600	7.20	11590	2.53	1505	3.76	3430	2.36	1315	4.08	4005	1.06	280	0.56	90	g 0.69	127	0.39	53	0.66	112	1.90	855
24	* 5.63	7120	5.44	6680	2.43	1395	3.57	3100	2.22	1165	3.64	3220	0.97	235	0.46	73	g 0.69	127	0.47	69	0.74	142	3.08	2273
25	* 5.33	6435	4.57	4905	2.35	1305	e 6.17	8495	2.74	1770	3.62	3185	0.90	200	0.42	59	g 0.69	127	0.55	87	0.96	218	3.04	2209
26	* 5.13	6015	4.14	4115	2.23	1175	6.15	8440	3.34	2708	3.00	2145	0.86	184	0.38	51	0.40	55	0.55	87	1.20	350	2.80	1855
27	* 4.93	5605	4.35	4490	2.13	1075	5.15	6055	2.90	2000	2.66	1665	0.82	168	0.36	47	0.43	61	0.53	83	1.47	524	2.52	1494
28	4.69	5135	7.77	13440	2.03	980	4.44	4655	2.68	1690	2.86	1940	0.78	154	0.34	43	0.46	67	0.52	80	1.76	738	2.30	1250
29	4.30	4400	....	.....	1.97	920	3.91	3700	2.46	1425	2.83	1900	0.75	145	0.32	39	0.46	67	0.57	93	2.24	1187	3.60	1590
30	3.73	3375	....	.....	1.89	845	3.49	2965	2.42	1380	2.50	1470	0.82	168	0.50	75	0.42	59	0.63	109	2.46	1426	7.29	11590
31	3.60	3150	....	.....	1.85	810	....	....	2.56	1540	....	....	0.86	184	0.40	55	....	...	0.63	109	....	....	5.88	7728

a. Max. 8 A.M., 11.23 = 27892 sec.-ft.
c. Max. 5 P.M., 8.27 = 15100 sec.-ft.
f. Max. 8 A.M., 13.09 = 36300 sec.-ft.
h. Frozen. Interpolated.

b. Ice gorge Feb. 8 to 15, just below bridge; broke on night of 15th.
d. Max. 8 A. M. 9.01 = 17805 sec.-ft. e. Max. 5 P.M. 7.26 = 11780 sec.-ft.
g. Chain broke after A.M. reading Sept. 16th. New chain put in Sept. 26th. Readings interpolated.
*Estimated.

Daily Gage Heights and Discharges of Youghiogheny River at Connellsville, Pa., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.70	5155	5.92	7832	4.25	4310	3.30	2640	3.34	2708	2.06	1007	2.52	1494	0.82	168
2	5.44	6682	5.19	6139	3.82	3536	3.19	2454	4.06	3968	1.62	630	2.22	1156	0.74	142
3	7.04	11094	4.60	4960	3.48	2946	3.50	2980	3.50	2980	1.39	469	2.06	1007	0.97	235
4	6.11	8328	4.06	3968	3.38	2876	3.96	3788	3.19	2454	1.32	423	1.88	838	1.31	416
5	4.92	5584	4.40	4580	3.08	2273	6.46	9330	2.90	2000	1.37	455	1.81	778	2.12	1055
6	4.42	4618	3.99	3842	3.22	2504	9.57	19923	2.62	1615	1.96	912	1.66	660	1.98	931
7	3.50	2980	3.62	3185	4.00	3860	7.65	13045	2.56	1542	4.10	4040	2.24	1187	1.44	503
8	3.25	2555	3.47	2929	3.58	3065	6.25	8720	2.46	1426	3.73	3377	2.37	1327	1.22	362
9	3.38	2776	3.54	3048	3.64	3220	6.08	8248	2.28	1229	3.07	2257	2.03	978	1.20	350
10	2.96	2086	3.24	2538	4.06	3968	5.92	7832	2.23	1176	2.53	1506	1.74	722	1.06	280
11	2.81	1870	3.90	3680	5.33	6436	5.23	6223	2.16	1105	2.28	1229	1.52	559	0.90	200
12	3.92	3716	3.02	2177	5.54	6912	4.42	4618	2.04	988	3.37	2759	1.56	587	0.88	192
13	10.28	22778	3.04	2203	4.93	5603	3.95	3770	1.96	912	3.86	3608	2.26	1208	0.82	168
14	10.79	25396	3.52	3014	4.64	5038	4.05	3950	1.89	847	3.34	2708	2.42	1382	0.82	168
15	8.13	14630	5.19	6139	4.41	4599	4.45	4675	1.76	738	2.89	1986	1.82	787	1.15	325
16	7.48	12486	4.63	5018	3.90	3680	4.56	4884	1.66	660	2.60	1590	1.50	545	1.82	787
17	6.02	8092	4.19	4202	3.64	3220	4.18	4004	1.64	645	3.82	3536	1.36	449	1.58	601
18	4.52	4808	4.34	4476	3.72	3360	3.99	3842	1.66	660	5.70	7280	1.24	374	1.48	531
19	4.11	4058	4.23	4274	4.96	5662	3.69	3308	1.64	645	6.72	10116	1.24	374	1.34	436
20	3.62	3185	4.15	4130	5.43	6659	4.20	4220	1.63	638	4.75	5252	1.16	330	1.19	345
21	3.53	3031	3.64	3220	4.88	5506	4.75	5252	1.62	630	3.82	3536	1.17	335	0.96	230
22	3.88	3644	3.30	2640	4.47	4713	5.34	6458	1.58	601	3.11	2321	1.18	340	0.88	192
23	3.64	3220	3.09	2289	4.11	4058	5.48	6774	1.54	573	2.73	1757	1.12	310	0.74	142
24	3.09	2289	2.98	2116	3.64	3220	4.79	5320	2.24	1187	2.42	1382	1.22	362	0.78	154
25	2.84	1913	2.96	2087	3.45	2895	4.32	4436	2.07	1016	3.42	2834	1.30	410	0.85	180
26	3.38	2776	3.84	3572	3.37	2759	3.92	3616	1.64	645	4.48	4732	1.24	374	1.00	250
27	5.00	5740	4.78	5311	3.34	2708	3.54	3048	1.62	630	4.45	4675	1.17	335	1.59	608
28	6.02	8092	4.84	5428	3.41	2827	3.27	2589	1.38	462	4.37	4526	1.01	255	1.89	847
29	9.32	18966	....	....	3.04	2209	3.28	2606	1.32	423	3.69	3308	0.94	220	3.78	3465
30	10.32	22942	....	....	3.16	2404	3.28	2606	1.35	442	2.94	2058	0.86	184	8.75	16845
31	9.28	18814	....	....	3.58	3116	....	....	1.50	545	....	....	0.84	176	8.42	15624

Estimated Monthly Discharge of Youghiogheny River at Connellsville, Pa.

[Drainage area, 1320 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1908					
August	698	53	217	0.164	0.183
September	106	11	41	0.031	0.034
October	71	29	36	0.027	0.030
November	100	41	68	0.052	0.058
December	2338	23	342	0.259	0.289
1909					
January	8170	195	1914	1.495	1.724
February	19115	545	5173	3.919	4.081
March	10025	1840	4017	3.043	3.508
April	17915	2690	5737	4.346	4.849
May	5845	700	2042	1.547	1.783
June	9660	1155	3353	2.540	2.834
July	960	210	415	0.314	0.362
August	5075	90	919	0.696	0.802
September	785	160	359	0.272	0.303
October	3840	85	731	0.554	0.639
November	650	360	478	0.362	0.404
December	4420	285	773	0.586	0.676
The year	19115	85	2165	1.639	21.965

Estimated Monthly Discharge of Youghiogheny River at Connellsville, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	26890	468	7211	5.470	6.306
February	15100	1315	5511	4.175	4.347
March	17805	810	3994	3.025	3.488
April	11780	490	2139	1.620	1.807
May	4060	1035	1744	1.321	1.523
June	36300	1470	5229	3.961	4.419
July	1095	145	574	0.435	0.502
August	220	39	99	0.075	0.086
September	912	55	236	0.179	0.200
October	109	14	44	0.033	0.038
November	1426	43	215	0.163	0.182
December	11590	250	1319	0.999	1.152
The year	36300	14	2351	1.788	24.050
1911					
January	25396	1870	7881	5.955	6.865
February	7832	2087	3893	2.949	3.071
March	6912	2209	3876	2.936	3.385
April	19923	2454	5505	4.170	4.652
May	3968	423	1164	0.882	1.016
June	10116	423	2875	2.178	2.430
July	1494	176	647	0.490	0.565
August	16845	142	1508	1.150	1.326

YOUGHIOGHENY RIVER AT CONFLUENCE, PA.

This station, situated on the two-span steel highway bridge, about ½ mile from the railroad station at Confluence, Somerset Co., Pa., was established September, 1904, by E. C. Murphy, for the U. S. Geological Survey, and in 1907 was taken over and has since been maintained by the Water Supply Commission of Pennsylvania.

A standard chain gage measuring 23.28 feet from marker to bottom of weight is fastened to the downstream handrail of bridge.

Bench Mark No. 1 is a cross on the head of a rivet in the bedplate on the downstream side of the right abutment, and has an elevation of 20.53 feet above the zero of the gage. Bench Mark No. 2 is a cross on the lower chord of the bridge under the gage box and has an elevation of 20.28 feet above the zero of the gage.

Discharge measurements are made from the upstream side of the bridge. The initial point for soundings is the center of the bridge pin over right abutment on the upstream side of bridge.

The channel is straight for about 200 feet above and 500 feet below the station. The bed of the stream is rocky. There is a small cobblestone dam about 6 inches high under the bridge. The right bank is high and does not overflow. The left bank is low and overflows during high water. There is an extreme range of about 16 feet between high and low water.

The joining of the Casselman River, Laurel Hill Creek and Youghiogheny River just below this station, together with the fact that the Youghiogheny below its junction has a cross-section inadequate to carry away the flood flow, causes back-water in all these streams at high water. No measurements have been made to ascertain the effect

of the back-water on the Youghiogheny itself, and while it is believed that it is but little affected, the higher discharges herein given should be used with caution.

The gage is read daily by L. L. Mountain.

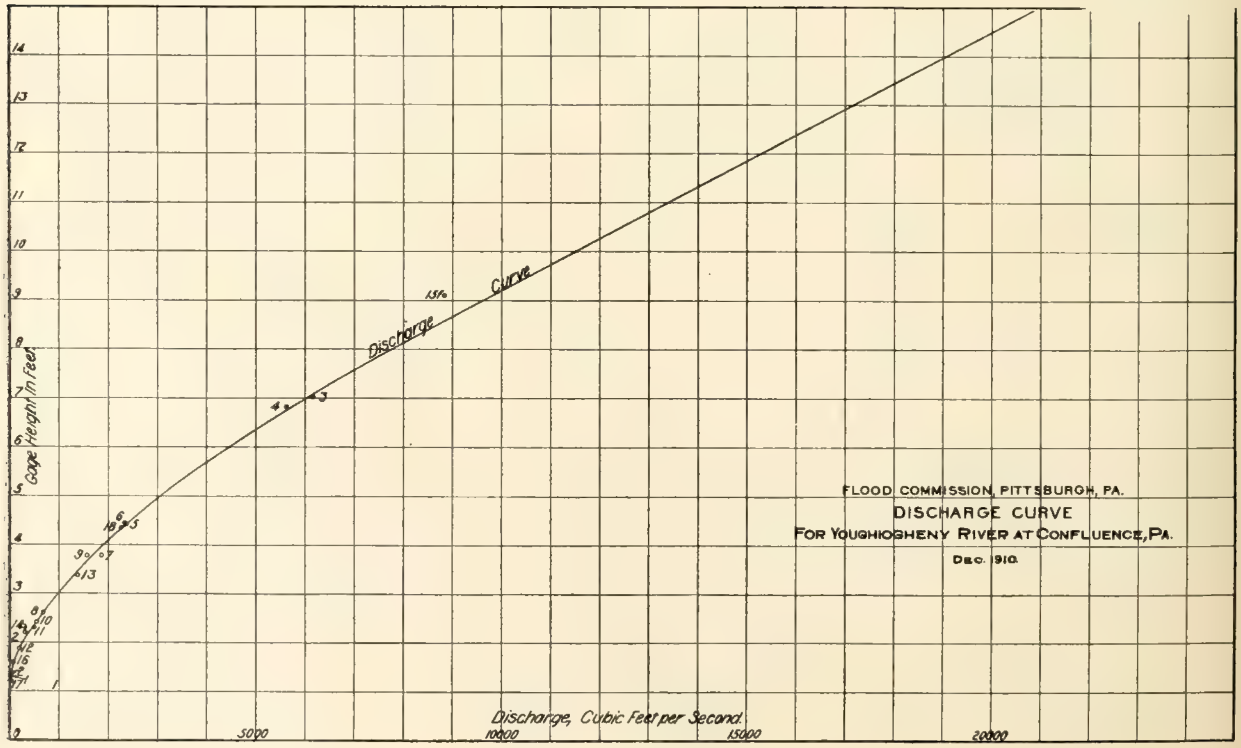
The drainage area above the station is 435 square miles.

Discharge Measurements of Youghiogheny River at Confluence, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1904							
Sept.	12	E. C. Murphy	78	64	0.55	1.30	35
Sept.	27	N. C. Grover	190	80	0.54	1.37	43
1905							
Mar.	11	E. C. Murphy	260	1365	4.52	7.02	6164
Mar.	11	do	260	1303	4.32	6.81	5628
Mar.	15	N. C. Grover	240	699	3.42	4.41	2380
Mar.	16	do	240	699	3.36	4.42	2344
Mar.	28	E. C. Murphy	231	553	3.39	3.78	1872
April	17	A. H. Horton	203	295	2.27	2.61	670
April	22	do	231	550	2.85	3.79	1567
June	5	R. H. Bolster	203	256	2.08	2.41	534
Nov.	4	Hanna and Grieve	203	251	1.99	2.30	499
1906							
May	25	U. S. Geological Survey	188	163	1.23	1.86	200
1907							
June	10	A. H. Horton	222	475	3.09	3.38	1390
Aug.	15	H. D. Padgett	201	196	1.56	2.20	307
1908							
Feb.	16	F. F. Henshaw	257	1900	4.66	a9.10	8850
Aug.	21	R. H. Bolster	178	98	0.78	1.59	76
Sept.	25b	F. E. Langenheim	75	69	0.33	1.20	23
1909							
June	12	F. W. Scheidenhelm	232	679	3.32	4.34	2253
1911							
July	13	F. E. Langenheim	134	316	1.25	2.75	396

a. Falling stage. b. Wading measurement.

PLATE 110



Rating Table for Youghiogheny River at Confluence, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.20	23	4.30	2237	7.40	6715	10.50	12450	13.60	18314
.30	33	.40	2351	.50	6890	.60	12640	.70	18503
.40	47	.50	2467	.60	7065	.70	12830	.80	18692
.50	67	.60	2585	.70	7242	.80	13020	.90	18881
.60	93	.70	2705	.80	7420	.90	13210	14.00	19070
.70	127	.80	2827	.90	7600	11.00	13400	.10	19259
.80	168	.90	2951	8.00	7780	.10	13589	.20	19448
.90	217	5.00	3077	.10	7964	.20	13778	.30	19637
2.00	271	.10	3207	.20	8148	.30	13967	.40	19826
.10	334	.20	3337	.30	8332	.40	14156	.50	20015
.20	399	.30	3470	.40	8516	.50	14345	.60	20204
.30	465	.40	3604	.50	8700	.60	14534	.70	20393
.40	533	.50	3742	.60	8884	.70	14723	.80	20582
.50	603	.60	3880	.70	9068	.80	14912	.90	20771
.60	674	.70	4023	.80	9252	.90	15101	15.00	20960
.70	746	.80	4166	.90	9436	12.00	15290	.10	21149
.80	820	.90	4313	9.00	9620	.10	15479	.20	21338
.90	896	6.00	4460	.10	9809	.20	15668	.30	21527
3.00	974	.10	4610	.20	9998	.30	15857	.40	21716
.10	1055	.20	4760	.30	10177	.40	16046	.50	21905
.20	1139	.30	4915	.40	10366	.50	16235	.60	22094
.30	1226	.40	5070	.50	10555	.60	16424	.70	22283
.40	1316	.50	5230	.60	10744	.70	16613	.80	22472
.50	1407	.60	5390	.70	10933	.80	16802	.90	22661
.60	1501	.70	5550	.80	11122	.90	16991	16.00	22850
.70	1598	.80	5710	.90	11311	13.00	17180	17.00	24740
.80	1698	.90	5875	10.00	11500	.10	17369	18.00	26630
.90	1801	7.00	6040	.10	11690	.20	17558	19.00	28520
4.00	1907	.10	6207	.20	11880	.30	17747	.....	.....
.10	2015	.20	6375	.30	12070	.40	17936	.....	.....
.20	2125	.30	6545	.40	12260	.50	18125	.....	.....

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1904

Day	September		October		November		December		Day	September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	..	1.30	35	1.35	42	1.40	50	17	1.35	42	1.60	94	1.40	50	b1.60	d94
2	....	..	1.30	35	1.35	42	1.40	50	18	1.35	42	1.60	94	1.40	50	a	d94
3	....	..	1.30	35	1.35	42	1.40	50	19	1.35	42	1.50	70	1.40	50	a	d94
4	....	..	1.25	28	1.35	42	1.40	50	20	1.35	42	1.45	60	1.40	50	a	d94
5	....	..	1.25	28	1.30	35	1.40	50	21	1.40	50	1.40	50	1.40	50	a	d94
6	....	..	1.25	28	1.30	35	1.40	50	22	1.40	50	1.40	50	1.40	50	a	d94
7	....	..	1.25	28	1.30	35	1.40	50	23	1.55	81	1.40	50	1.40	50	a	d94
8	....	..	1.30	35	1.30	35	1.40	50	24	1.55	81	1.40	50	1.40	50	b1.90	94
9	....	..	1.35	42	1.30	35	1.40	50	25	1.50	70	1.40	50	1.40	50	c4.80	2850
10	....	..	1.35	42	1.35	42	1.40	50	26	1.40	50	1.40	50	1.40	50	4.25	2165
11	....	..	1.40	50	1.35	42	a	d50	27	1.40	50	1.40	50	1.40	50	4.50	2460
12	....	..	1.40	50	1.35	42	a	d50	28	1.35	42	1.35	42	1.40	50	4.90	2990
13	....	..	1.40	50	1.35	42	a	d70	29	1.35	42	1.35	42	1.40	50	3.80	1695
14	....	..	1.70	124	1.35	42	a	d70	30	1.35	42	1.35	42	1.40	50	3.00	995
15	....	..	1.70	124	1.35	42	a	d94	31	....	..	1.35	42	....	..	2.70	750
16	1.35	42	1.65	108	1.35	42	a	d94									

a. Frozen.
b. Hole cut in ice and gage read to surface of water.
c. Ice gone out.
d. Discharge estimated.

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1905.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	2.45	556	2.35	479	3.55	1465	2.75	790	2.55	633	3.20	1165
2	2.35	479	2.30	441	3.55	*1465	2.60	672	2.40	518	2.80	830
3	2.60	672	2.35	479	3.55	*1465	2.60	672	2.35	479	2.70	750
4	2.50	595	2.30	441	3.55	1465	2.50	595	2.25	405	2.50	595
5	2.45	556	....	....	4.28	*2210	2.55	633	2.25	405	2.40	518
6	2.40	518	....	....	4.91	*2955	2.65	711	2.30	441	2.30	441
7	2.25	405	....	....	5.40	3700	2.75	790	2.30	441	3.00	995
8	2.20	370	2.55	633	5.45	3771	2.90	910	2.35	479	2.90	910
9	2.10	308	....	....	7.85	7140	2.90	910	2.25	405	2.75	790
10	2.15	339	....	....	8.70	8330	3.05	1037	2.25	405	2.60	672
11	2.20	370	2.65	711	6.75	5600	3.95	1847	2.40	518	4.70	2710
12	2.45	556	....	....	5.65	4055	3.55	1465	3.00	995	3.60	1510
13	6.35	5040	....	....	5.05	3205	3.30	1250	2.85	870	3.50	1420
14	4.70	2710	....	....	4.70	2710	2.95	952	3.20	1165	3.10	1080
15	3.55	1465	3.05	1037	4.45	2400	2.85	870	4.05	1952	2.70	750
16	3.15	1123	....	....	4.45	2400	2.75	790	3.85	1745	2.45	556
17	2.90	910	....	....	5.70	4126	2.60	672	3.70	1600	2.40	518
18	2.75	790	3.35	1292	6.45	5180	2.60	672	3.40	1335	2.30	441
19	2.60	672	....	....	8.70	8330	2.50	595	3.00	995	2.20	370
20	2.55	633	....	....	8.45	7980	2.75	790	2.85	870	2.20	370
21	2.50	595	....	....	10.25	10500	3.05	1037	2.75	790	2.10	308
22	2.40	518	3.45	1377	8.05	7420	3.80	1695	2.60	672	3.35	1292
23	2.45	556	....	....	5.85	4338	3.45	1377	2.50	595	3.10	1080
24	2.35	479	....	....	4.90	2990	3.10	1080	2.35	479	3.40	1335
25	2.40	518	3.55	1465	5.20	3417	3.00	995	2.30	441	3.00	995
26	2.40	518	....	....	4.55	2520	2.80	830	2.25	405	2.80	830
27	2.30	441	....	....	4.15	2057	2.90	910	2.20	370	3.45	1377
28	2.35	479	....	....	3.70	1600	2.85	870	2.15	339	2.90	910
29	2.30	441	....	....	3.30	1250	2.85	870	2.00	250	2.60	672
30	2.35	479	....	....	3.15	1122	2.60	672	2.05	279	2.50	595
31	2.30	441	....	....	2.90	910	....	...	2.10	308	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	2.45	556	3.60	1510	2.10	308	1.60	94	2.50	595	3.95	1847
2	3.65	1555	3.00	995	2.05	279	1.60	94	2.40	518	3.50	1420
3	3.15	1122	2.70	750	2.05	279	1.80	160	2.30	441	8.05	7420
4	3.00	995	2.55	633	2.05	279	1.75	140	2.30	441	5.60	3984
5	3.90	1795	2.50	595	2.10	308	1.70	124	2.30	441	4.35	2282
6	3.60	1510	2.35	479	2.20	370	1.65	108	2.45	556	3.70	1600
7	4.50	2460	2.20	370	2.25	405	1.65	108	2.40	518	3.35	1292
8	4.80	2850	2.10	308	2.55	633	1.60	94	2.35	479	3.10	1080
9	3.85	1745	2.10	308	2.75	790	1.60	94	2.30	441	2.90	910
10	3.30	1250	2.05	279	2.90	910	1.55	81	2.30	441	2.80	830
11	3.15	1122	2.30	441	3.50	1420	1.70	124	2.20	370	2.75	790
12	3.00	995	2.20	370	3.75	1647	2.30	441	2.20	370	2.70	750
13	3.10	1080	2.10	308	3.10	1080	3.20	1165	2.15	339	2.60	672
14	2.85	870	2.05	279	2.60	672	2.00	250	2.15	339	2.50	595
15	2.55	633	4.50	2460	2.20	370	1.90	202	2.20	370	2.40	518
16	2.35	479	4.10	2005	2.15	339	1.80	160	2.20	370	2.35	479
17	2.20	370	3.20	1165	3.10	1080	1.75	140	2.30	441	2.30	441
18	2.15	339	2.70	750	2.05	279	1.70	124	2.30	441	2.25	405
19	2.10	308	2.40	518	2.00	250	1.90	202	2.35	479	2.25	405
20	2.20	370	2.30	441	1.95	225	6.15	4760	2.20	370	2.20	370
21	2.70	750	2.20	370	1.90	202	4.10	2005	2.10	308	3.80	1695
22	2.40	518	2.10	308	1.80	160	3.25	1207	2.05	279	4.60	2580
23	2.30	441	2.10	308	1.80	160	2.80	830	2.05	279	4.20	2110
24	2.70	750	2.00	250	1.80	160	2.60	672	2.00	250	4.00	1900
25	2.50	595	2.50	595	1.80	160	3.50	1420	2.10	308	3.50	1420
26	2.25	405	4.00	1900	1.75	140	3.50	1420	2.05	279	3.10	1080
27	2.10	308	2.95	952	1.70	124	3.30	1250	2.05	279	2.95	952
28	2.05	279	2.65	711	1.70	124	3.00	995	2.40	518	2.85	870
29	2.40	518	2.30	441	1.65	108	2.80	830	5.40	3700	3.10	1080
30	4.40	2340	2.25	405	1.60	94	2.65	711	5.35	3629	2.85	870
31	4.00	1900	2.20	370	....	...	2.55	633	....	....	2.75	790

From Feb. 5 to Mar. 6, river frozen entirely across, except for narrow channel of open water under gage. Ice 0.7 ft. to 1.0 ft. thick. *Estimated.

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1906.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.60	672	2.60	672	2.50	595	6.10	4690	3.10	1080	2.45	556
2	2.50	595	2.50	595	2.50	595	5.10	3276	3.30	1250	2.50	595
3	2.85	870	2.45	556	2.50	595	4.80	2850	3.20	1165	2.35	479
4	5.35	3629	2.40	518	2.75	790	4.80	2850	3.00	995	2.25	405
5	4.40	2340	2.35	479	3.40	1335	5.20	3417	2.90	910	2.20	370
6	3.70	1600	2.25	405	3.20	1165	7.00	5950	2.80	830	4.40	2340
7	3.30	1250	2.15	339	3.00	995	5.50	3842	2.70	750	5.20	3417
8	3.20	1165	1.90	202	2.85	870	4.50	2460	2.60	672	3.90	1795
9	3.70	1600	1.90	202	2.75	790	4.40	2340	2.60	672	3.35	1292
10	2.50	595	1.95	225	2.75	790	5.75	4197	2.60	672	2.90	910
11	2.70	750	2.00	250	2.80	830	4.80	2850	2.55	633	2.70	750
12	3.30	1250	2.20	370	2.85	870	4.10	2005	2.50	595	2.60	672
13	2.70	750	2.15	339	2.75	790	3.80	1695	2.40	518	2.50	595
14	2.70	750	2.10	308	2.70	750	3.60	1510	2.30	441	2.40	518
15	2.75	790	2.05	279	2.75	790	5.20	3417	2.25	405	2.35	479
16	2.85	870	2.05	279	2.75	790	4.70	2710	2.20	370	2.25	405
17	3.55	1465	2.00	250	2.70	750	4.10	2005	2.15	339	2.15	339
18	3.80	1695	2.05	279	2.65	711	3.70	1600	2.10	308	2.10	308
19	4.35	2282	2.10	308	2.70	750	3.40	1335	2.10	308	2.05	279
20	3.80	1695	2.20	370	2.75	790	3.10	1080	2.05	279	2.30	441
21	3.80	1695	2.20	370	2.60	672	3.10	1080	2.00	250	3.10	1080
22	3.85	1745	2.40	518	2.50	595	3.20	1165	2.00	250	2.90	910
23	10.00	10150	2.65	711	2.50	595	3.35	1292	1.95	225	2.80	830
24	6.40	5110	2.60	672	2.80	830	3.40	1335	1.90	202	2.80	830
25	4.80	2850	2.45	556	3.00	995	3.40	1335	1.85	180	2.60	672
26	4.00	1900	2.30	441	2.70	750	3.40	1335	1.85	180	2.50	595
27	3.50	1420	2.30	441	5.50	3842	4.65	2645	1.80	160	2.50	595
28	3.30	1250	2.35	479	8.00	7350	3.90	1795	2.30	441	2.45	556
29	3.10	1080	....	...	6.40	5110	3.50	1420	2.35	479	2.75	790
30	2.90	910	....	...	7.70	6930	3.25	1207	2.30	441	2.50	595
31	2.80	830	....	...	8.60	8190	....	....	2.40	518	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Ht. Gage	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.45	556	2.20	370	1.90	202	1.80	160	2.10	308	2.30	441
2	2.40	518	2.10	308	1.90	202	1.75	140	2.20	370	2.30	441
3	2.20	370	2.40	518	1.80	160	1.75	140	1.95	225	2.65	711
4	2.15	339	2.10	308	1.80	160	1.85	180	1.80	160	2.50	595
5	2.15	339	2.00	250	1.75	140	2.10	308	1.80	160	2.35	479
6	2.10	308	1.90	202	1.70	124	2.20	370	1.85	180	3.30	1250
7	2.00	250	1.90	202	1.70	124	2.35	479	1.80	160	4.10	2005
8	1.95	225	4.40	2340	1.65	108	2.25	405	1.75	140	3.50	1420
9	1.90	202	7.40	6510	1.65	108	2.10	308	1.75	140	3.10	1080
10	1.90	202	8.20	7630	1.80	160	2.05	279	1.80	160	6.40	5110
11	1.85	180	5.10	3276	1.80	160	2.00	250	1.80	160	8.10	7490
12	1.85	180	3.90	1795	1.60	94	2.00	250	1.85	180	5.55	3913
13	1.80	160	3.40	1335	1.65	108	1.95	225	1.80	160	4.40	2340
14	1.80	160	3.00	995	2.00	250	1.95	225	1.80	160	3.95	1847
15	1.75	140	2.80	830	1.80	160	1.90	202	1.85	180	3.65	1555
16	1.75	140	2.55	633	1.70	124	1.90	202	1.90	202	4.20	2110
17	1.75	140	2.55	633	1.65	108	1.85	180	2.00	250	5.85	4338
18	1.80	160	2.50	595	1.95	225	1.85	180	3.00	995	6.40	5110
19	1.70	124	2.70	750	1.90	202	1.85	180	3.50	1420	4.80	2850
20	1.70	124	3.60	1510	1.90	202	2.00	250	4.40	2340	4.10	2005
21	1.70	124	4.00	1900	1.85	180	2.30	441	4.00	1900	3.90	1795
22	1.80	160	3.15	1122	1.85	180	2.40	518	3.35	1292	3.60	1510
23	2.80	830	2.70	750	1.85	180	2.30	441	2.90	910	3.25	1207
24	2.40	518	2.60	672	1.80	160	2.15	339	2.70	750	3.00	995
25	2.20	370	2.60	672	1.80	160	2.05	279	2.55	633	2.80	830
26	2.00	250	2.35	479	1.75	140	1.95	225	2.45	556	2.80	830
27	1.80	160	2.35	479	1.75	140	1.95	225	2.35	479	2.85	870
28	1.75	140	2.25	405	1.70	124	1.90	202	2.30	441	3.50	1420
29	1.70	124	2.15	339	1.70	124	1.95	225	2.25	405	4.90	2990
30	2.50	595	2.10	308	1.80	160	2.05	279	2.20	370	5.35	3629
31	2.30	441	2.00	250	....	...	2.10	308	....	...	7.50	6650

Note. Discharge probably unaffected by ice conditions.

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1907.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.30	4970	2.65	711	3.20	1165	2.45	556	3.10	1080	3.20	1165	2.20	370	2.90	910	2.05	279	2.05	279	2.30	441	3.20	1165
2	4.90	2990	3.20	1165	4.15	2057	2.40	518	3.00	995	5.55	3913	2.70	750	2.70	750	2.00	250	1.95	225	2.35	479	3.00	995
3	4.40	2340	6.35	5040	3.60	1510	2.30	441	2.95	952	4.50	2460	2.55	633	2.60	672	2.65	711	1.90	202	6.00	4550	3.10	1080
4	3.90	1795	5.00	3135	3.40	1335	2.25	405	3.20	1165	3.50	1420	2.35	479	2.50	595	2.60	672	2.10	308	4.70	2710	3.90	1795
5	3.70	1600	3.75	1647	3.25	1207	2.25	405	2.90	910	4.50	2460	2.10	308	2.50	595	2.50	595	2.10	308	4.30	2225	3.00	995
6	3.40	1335	3.65	1555	3.10	1080	2.20	370	2.85	870	4.80	2850	2.05	279	3.40	1335	2.20	370	2.55	633	4.10	2005	2.50	595
7	3.40	1335	3.60	1510	3.00	995	2.25	405	3.15	1122	4.20	2110	2.00	250	3.10	1080	2.05	279	2.45	556	6.75	5600	2.75	790
8	3.90	1795	3.30	1250	2.95	952	2.40	518	3.15	1122	4.05	1952	1.95	225	3.00	995	2.05	279	2.40	518	5.25	3487	3.00	995
9	6.75	5600	3.15	1122	2.90	910	2.40	518	8.25	7700	3.60	1510	1.90	202	2.90	910	2.05	279	3.00	995	5.10	3276	3.20	1165
10	5.00	3135	2.80	830	3.00	995	2.75	790	5.25	3487	3.20	1165	1.90	202	2.80	830	2.00	250	2.70	750	4.25	2167	5.95	4479
11	4.20	2110	2.70	750	3.50	1420	2.80	830	4.40	2340	5.15	3346	2.80	830	2.75	790	2.45	556	2.50	595	3.80	1695	5.85	4338
12	11.15	11760	2.65	711	3.50	1420	3.00	995	4.00	1900	3.85	1745	5.35	3629	2.60	672	2.50	595	2.40	518	3.60	1510	5.60	3984
13	7.25	6300	2.65	711	16.20	18730	3.00	995	3.40	1335	4.05	1952	3.85	1745	2.50	595	2.30	441	2.45	556	2.15	339	5.40	3700
14	11.60	12390	2.60	672	19.00	22650	3.10	1080	3.05	1037	5.30	3558	3.05	1037	2.40	518	2.10	308	2.30	441	2.95	952	5.00	3135
15	8.90	8610	2.90	910	9.50	9450	3.00	995	2.85	870	4.05	1952	2.70	750	2.30	441	2.00	250	2.25	405	2.75	790	4.60	2580
16	6.70	5530	2.85	870	6.50	5250	3.70	1600	2.85	870	3.60	1510	2.50	595	2.20	370	1.90	202	2.40	518	2.55	633	4.30	2225
17	6.30	4970	2.80	830	5.00	3135	3.70	1600	2.75	790	3.40	1335	5.20	3417	2.10	308	1.90	202	2.40	518	2.50	595	4.00	1900
18	8.10	7490	2.75	790	4.40	2340	3.45	1377	2.65	711	3.10	1080	6.10	4690	2.10	308	2.05	279	2.25	405	2.60	672	3.85	1745
19	12.65	13860	3.00	995	14.00	15750	3.30	1250	2.85	870	2.85	870	4.60	2580	2.10	308	2.30	441	2.15	339	3.10	1080	2.50	595
20	9.30	9170	3.85	1745	10.70	11130	3.30	1250	4.40	2340	2.75	790	3.80	1695	2.00	250	2.30	441	2.10	308	2.80	830	2.40	518
21	6.20	4830	3.40	1335	6.70	5530	3.25	1207	3.65	1555	2.70	750	3.20	1165	1.90	202	2.20	370	2.10	308	2.65	711	2.35	479
22	4.80	2850	3.10	1080	5.70	4126	3.20	1165	3.55	1465	2.60	672	3.20	1165	1.90	202	2.10	308	2.00	250	2.85	870	2.50	595
23	4.10	2005	3.05	1037	4.30	2225	3.20	1165	3.45	1377	2.40	518	4.60	2580	2.20	370	2.10	308	1.95	225	2.80	830	6.05	4620
24	3.70	1600	3.00	995	3.75	1647	5.30	3558	3.35	1292	2.60	672	4.00	1900	4.00	1900	2.40	518	1.90	202	2.80	830	7.25	6300
25	4.00	1900	2.95	952	3.35	1292	4.40	2340	3.05	1037	2.30	441	3.80	1695	3.55	1465	2.15	339	1.85	180	2.90	910	5.75	4197
26	3.70	1600	2.90	910	3.10	1080	3.85	1745	3.15	1122	2.30	441	6.60	5390	3.10	1080	2.10	308	1.90	202	3.00	995	4.70	2710
27	3.30	1250	2.90	910	3.00	995	3.70	1600	3.25	1207	2.30	441	5.35	3629	2.75	790	2.00	250	2.00	250	3.15	1122	3.85	1745
28	3.05	1037	3.00	995	2.85	870	3.55	1465	3.20	1165	2.20	370	4.20	2110	2.55	633	1.90	202	3.30	1250	3.25	1207	5.00	3135
29	2.90	910	....	...	2.80	830	3.40	1335	3.10	1080	2.20	370	3.70	1600	2.35	479	1.85	180	2.75	790	3.75	1647	5.20	3417
30	2.80	830	....	...	2.65	711	3.20	1165	2.90	910	2.20	370	3.35	1292	2.20	370	2.10	308	2.35	479	3.15	1122	4.20	2110
31	2.70	750	....	...	2.55	633	....	....	2.90	910	....	...	2.95	952	2.10	308	....	...	2.40	518	....	....	4.10	2005

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1908.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.80	1695	3.30	1250	2.70	750	4.75	2780	2.60	672	2.95	952
2	3.60	1510	2.95	952	7.50	6650	4.75	2780	2.50	595	2.75	790
3	3.50	1420	2.75	790	7.20	6230	4.05	1952	2.50	595	2.60	672
4	3.00	995	2.60	672	5.50	3842	3.65	1555	3.55	1465	2.50	595
5	2.95	952	2.55	633	5.10	3276	3.40	1335	7.85	7140	2.45	556
6	2.90	910	2.55	633	7.40	6510	3.40	1335	6.70	5530	2.40	518
7	2.65	711	2.70	750	10.90	11410	3.20	1165	10.25	10500	2.50	595
8	2.50	595	2.60	672	7.75	7000	3.90	1795	8.10	7490	2.35	479
9	2.65	711	2.55	633	10.05	10220	5.40	3700	6.15	4760	2.20	370
10	2.55	633	2.55	633	6.60	5390	4.55	2520	5.25	3487	2.10	308
11	2.45	556	2.60	672	5.30	3558	7.25	6300	4.45	2400	2.00	250
12	6.45	5180	2.70	750	5.00	3135	4.95	3062	3.85	1745	2.00	250
13	5.80	4268	3.75	1647	5.00	3135	4.20	2110	3.50	1420	1.95	225
14	5.35	3629	5.65	4055	5.30	3558	3.75	1647	3.35	1292	1.90	202
15	4.65	2645	15.00	17150	5.00	3135	3.60	1510	3.90	1795	2.05	279
16	3.65	1555	8.75	8400	4.80	2850	3.50	1420	3.60	1510	2.00	250
17	3.30	1250	5.80	4268	4.40	2340	3.40	1335	3.40	1335	1.95	225
18	2.95	952	4.95	3062	4.50	2460	3.30	1250	3.25	1207	1.90	202
19	2.80	830	4.00	1900	11.00	11550	4.30	2225	4.30	2225	1.90	202
20	2.65	711	3.50	1420	6.75	5600	4.00	1900	5.30	3558	1.85	180
21	2.70	750	3.20	1165	4.90	2990	3.35	1292	5.60	3984	1.85	180
22	3.10	1080	3.15	1122	4.15	2057	3.20	1165	6.60	5390	1.90	202
23	3.20	1165	2.90	910	3.80	1695	3.10	1080	4.40	2340	1.90	202
24	3.05	1037	2.80	830	3.75	1647	3.00	995	4.40	2340	1.85	180
25	3.00	995	2.70	750	3.25	1207	2.90	910	3.90	1795	1.85	180
26	3.25	1207	2.70	750	3.00	995	2.80	830	3.60	1510	1.80	160
27	3.95	1847	2.70	750	2.85	870	2.60	672	3.50	1420	1.70	124
28	3.75	1647	2.70	750	2.80	830	2.45	556	3.30	1250	1.65	108
29	3.10	1080	2.65	711	3.65	1555	2.45	556	3.60	1510	1.65	108
30	2.85	870	....	...	3.80	1695	2.40	518	4.20	2110	1.60	94
31	3.70	1600	....	...	4.55	2520	....	...	3.30	1250	....	...

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.60	94	1.65	108	1.50	70	1.30	35	1.30	35	1.30	35
2	1.60	94	1.60	94	1.50	70	1.30	35	1.30	35	1.30	35
3	1.60	94	1.60	94	1.50	70	1.30	35	1.30	35	1.30	35
4	1.60	94	1.55	81	1.45	60	1.30	35	1.30	35	1.30	35
5	1.60	94	1.55	81	1.45	60	1.30	35	1.30	35	1.25	28
6	1.55	81	1.55	81	1.45	60	1.30	35	1.30	35	1.25	28
7	1.55	81	2.05	279	1.45	60	1.30	35	1.30	35	1.40	50
8	1.55	81	1.90	202	1.45	60	1.25	28	1.30	35	1.50	70
9	1.50	70	1.70	124	1.45	60	1.25	28	1.30	35	1.40	50
10	1.50	70	1.50	70	1.40	50	1.25	28	1.30	35	1.50	70
11	1.50	70	1.50	70	1.40	50	1.25	28	1.30	35	1.50	70
12	1.50	70	1.50	70	1.40	50	1.25	28	1.30	35	1.60	94
13	1.50	70	1.45	60	1.40	50	1.25	28	1.30	35	1.70	124
14	1.70	124	1.45	60	1.35	42	1.25	28	1.30	35	1.70	124
15	1.85	180	1.40	50	1.35	42	1.25	28	1.30	35	1.70	124
16	1.85	180	1.40	50	1.30	35	1.25	28	1.30	35	1.70	124
17	1.85	180	1.40	50	1.30	35	1.25	28	1.30	35	1.70	124
18	1.80	160	2.35	479	1.25	28	1.25	28	1.35	42	2.20	370
19	1.95	225	2.00	250	1.25	28	1.25	28	1.35	42	2.80	830
20	1.85	180	1.75	140	1.25	28	1.25	28	1.40	50	2.30	441
21	1.70	124	1.55	81	1.20	23	1.25	28	1.40	50	2.00	250
22	1.60	94	1.50	70	1.20	23	1.25	28	1.40	50	1.85	180
23	1.50	70	1.50	70	1.20	23	1.25	28	1.40	50	1.85	180
24	2.45	556	1.70	124	1.20	23	1.25	28	1.40	50	1.85	180
25	2.20	370	1.70	124	1.20	23	1.30	35	1.40	50	1.80	160
26	2.10	308	1.65	108	1.20	23	1.30	35	1.35	42	1.70	124
27	2.00	250	1.65	108	1.20	23	1.30	35	1.35	42	1.60	94
28	1.90	202	1.65	108	1.30	35	1.30	35	1.35	42	1.70	124
29	1.85	180	1.60	94	1.30	35	1.30	35	1.35	42	1.70	124
30	1.75	140	1.55	81	1.30	35	1.30	35	1.30	35	1.70	124
31	1.70	124	1.50	70	....	..	1.30	35	....	..	1.75	140

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	**Feet**	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	**Feet**	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.75	140	2.25	405	3.60	1510	3.00	995	3.80	1695	2.70	750	2.20	370	1.60	94	1.75	140	1.55	81	2.00	250	1.90	202
2	2.00	250	2.50	595	3.90	1795	3.00	995	3.70	1600	3.00	995	2.10	308	1.60	94	1.70	124	1.55	81	2.00	250	1.85	180
3	2.05	279	2.50	595	4.60	2580	3.20	1165	3.50	1420	3.35	1292	2.05	279	1.60	94	1.70	124	1.50	70	1.95	225	1.85	180
4	1.80	160	2.40	518	4.60	2580	3.90	1795	3.60	1510	3.20	1165	2.00	250	1.60	94	1.70	124	1.50	70	1.95	225	1.85	180
5	1.80	160	2.50	595	4.40	2340	3.85	1745	3.40	1335	5.00	3135	2.00	250	1.60	94	1.80	160	1.50	70	1.90	202	1.85	180
6	1.90	202	3.60	1510	3.80	1695	3.75	1647	3.00	995	5.35	3629	1.90	202	1.60	94	1.90	202	1.50	70	1.85	180	1.80	160
7	1.90	202	3.35	1292	3.40	1335	3.45	1377	2.80	830	4.10	2005	1.80	160	1.55	81	1.80	160	1.45	60	1.80	160	1.90	202
8	1.85	180	2.90	910	4.20	2110	3.20	1165	2.70	750	4.05	1952	1.75	140	1.55	81	1.75	140	1.45	60	1.80	160	2.40	518
9	1.80	160	2.80	830	4.20	2110	3.00	995	2.65	711	3.75	1647	1.70	124	1.50	70	1.70	124	1.45	60	2.00	250	2.40	518
10	2.00	250	3.00	995	4.50	2460	2.90	910	2.60	672	3.90	1795	1.65	108	1.45	60	1.65	108	1.40	50	2.10	308	2.20	370
11	1.90	202	3.90	1795	3.90	1795	2.85	870	2.50	595	5.30	3558	1.65	108	1.45	60	1.70	124	1.55	81	2.00	250	2.10	308
12	2.00	250	3.75	1647	3.40	1335	2.80	830	2.40	518	4.30	2225	1.65	108	1.40	50	2.15	339	2.25	405	2.00	250	2.10	308
13	2.10	308	3.60	1510	3.25	1207	2.75	790	2.30	441	3.60	1510	1.65	108	1.40	50	2.05	279	2.15	339	2.00	250	2.40	518
14	2.30	441	4.00	1900	3.15	1122	6.05	4620	2.25	405	3.70	1600	1.65	108	1.40	50	1.90	202	1.90	202	1.95	225	3.40	1335
15	4.85	2920	3.90	1795	3.00	995	4.85	2920	2.20	370	3.60	1510	1.65	108	1.45	60	1.80	160	1.90	202	1.95	225	2.60	672
16	4.00	1900	6.00	4550	2.90	910	4.00	1900	2.15	339	3.60	1510	1.60	94	3.05	1037	1.70	124	1.85	180	1.95	225	2.50	595
17	3.35	1292	4.50	2460	2.80	830	3.50	1420	2.20	370	3.95	1847	1.60	94	3.50	1420	2.50	595	1.80	160	1.95	225	2.35	479
18	2.85	870	3.90	1795	2.80	830	3.15	1122	2.10	308	3.25	1207	1.60	94	2.90	910	2.10	308	1.75	140	1.95	225	2.25	405
19	2.50	595	3.60	1510	2.75	790	3.10	1080	2.00	250	3.05	1037	1.60	94	2.60	672	2.00	250	1.75	140	1.95	225	2.15	339
20	2.70	750	3.85	1745	3.10	1080	3.65	1555	2.00	250	2.90	910	1.60	94	2.35	479	1.90	202	1.75	140	1.95	225	2.05	279
21	2.60	672	3.50	1420	2.90	910	5.85	4338	2.05	279	2.80	830	1.55	81	3.20	1165	1.80	160	1.75	140	1.95	225	2.00	250
22	2.80	830	3.25	1207	2.80	830	7.20	6230	2.30	441	2.70	750	1.50	70	2.40	518	1.80	160	1.90	202	1.95	225	2.00	250
23	3.60	1510	3.65	1555	2.65	711	5.95	4479	2.20	370	2.65	711	1.50	70	2.10	308	1.75	140	2.10	308	1.95	225	1.90	202
24	4.70	2710	8.10	7490	2.55	633	5.05	3205	2.05	279	2.60	672	1.65	108	1.90	202	1.75	140	5.00	3135	1.90	202	1.90	202
25	3.90	1795	6.50	5250	2.75	790	4.20	2110	2.00	250	2.40	518	1.70	124	1.80	160	1.75	140	3.50	1420	1.90	202	2.00	250
26	3.70	1600	5.00	3135	3.10	1080	4.05	1952	2.00	250	2.25	405	1.70	124	1.70	124	1.75	140	2.90	910	1.90	202	2.10	308
27	2.90	910	4.45	2400	3.30	1250	3.60	1510	2.30	441	2.15	339	1.65	108	1.70	124	1.70	124	2.40	518	1.90	202	2.10	308
28	2.80	830	4.15	2057	3.50	1420	3.40	1335	3.15	1122	2.00	250	1.65	108	1.70	124	1.65	108	2.40	518	1.85	180	2.10	308
29	2.70	750	....	....	3.40	1335	3.20	1165	2.90	910	2.00	250	1.65	108	1.85	180	1.65	108	2.30	441	1.90	202	2.10	308
30	2.25	405	....	....	3.30	1250	3.30	1250	2.60	672	2.00	250	1.65	108	1.85	180	1.60	94	2.20	370	1.90	202	2.10	308
31	1.75	140	....	....	3.10	1080	....	....	2.50	595	....	...	1.65	108	1.85	180	....	...	2.10	308	....	...	2.10	308

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.25	432	2.95	935	7.05	6123	1.95	244	2.70	746	3.00	974
2	3.35	1271	2.85	858	6.40	5070	1.95	244	2.55	638	3.90	1801
3	10.80	13020	2.90	896	5.40	3604	1.90	217	2.45	568	3.90	1801
4	7.35	6630	2.85	858	4.85	2889	1.90	217	2.35	499	3.60	1501
5	4.65	2645	2.55	638	4.55	2526	1.95	244	2.30	465	3.85	1750
6	4.85	2889	2.20	399	4.40	2351	1.95	244	2.30	465	4.60	2585
7	5.30	3470	2.00	271	3.90	1801	1.90	217	2.25	432	3.95	1854
8	4.95	3014	2.00	271	3.50	1407	1.90	217	2.20	399	3.35	1271
9	3.90	1801	2.50	603	3.20	1139	1.90	217	2.30	465	3.25	1182
10	3.35	1271	3.60	674	2.90	896	1.90	217	2.30	465	3.95	1854
11	3.00	974	3.35	1271	2.75	783	1.90	217	2.35	499	4.30	2237
12	2.95	935	3.15	1097	2.65	710	1.90	217	3.05	1014	4.10	2015
13	2.85	858	3.00	974	2.55	638	1.90	217	2.90	896	3.80	1698
14	2.80	820	2.85	858	2.50	603	1.85	192	2.95	935	3.60	1501
15	2.80	820	2.75	783	2.45	568	1.85	192	2.75	783	3.45	1361
16	2.80	820	4.85	2889	2.40	533	1.85	192	2.55	638	3.40	1316
17	2.80	820	5.80	4166	2.35	499	1.85	192	2.40	533	4.10	2015
18	a 10.70	12830	5.20	3337	2.30	465	1.80	168	2.30	465	3.95	1854
19	7.90	7600	4.00	1907	2.30	465	1.80	168	2.40	533	12.20	15668
20	5.15	3272	3.45	1361	2.50	603	1.80	168	2.40	533	6.70	5550
21	6.80	5710	3.90	1801	2.40	533	1.85	192	2.35	499	4.30	2237
22	5.35	3537	7.25	6460	2.30	465	3.10	1055	2.30	465	3.90	1801
23	4.15	2070	5.60	3880	2.20	399	3.25	1182	2.25	432	3.55	1454
24	3.65	1549	4.45	2409	2.15	366	3.05	1014	2.30	465	3.30	1226
25	3.35	1271	3.70	1598	2.15	366	5.55	3811	2.85	858	3.20	1139
26	3.25	1182	3.60	1501	2.10	334	4.45	2409	2.90	896	3.00	974
27	4.35	2294	3.70	1598	2.10	334	3.75	1648	2.70	746	2.80	820
28	3.90	1801	6.20	4760	2.00	271	3.60	1501	2.60	674	2.70	746
29	3.50	1407	....	....	2.00	271	3.40	1316	2.55	638	2.50	603
30	3.30	1226	....	....	1.95	244	3.10	1055	2.50	603	2.35	499
31	3.05	1014	....	....	1.95	244	....	....	2.50	603	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.25	432	1.60	93	1.60	93	1.35	40	1.40	47	1.80	168
2	2.25	432	1.60	93	1.70	127	1.35	40	1.45	57	1.80	168
3	2.20	399	1.55	80	1.70	127	1.35	40	1.45	57	1.80	168
4	2.15	366	1.55	80	2.15	366	1.30	33	1.45	57	1.80	168
5	2.10	334	1.50	67	2.15	366	1.30	33	1.45	57	1.80	168
6	2.10	334	1.50	67	1.80	168	1.30	33	1.40	47	1.90	217
7	2.05	301	1.50	67	1.75	147	1.30	33	1.40	47	1.90	217
8	2.00	271	1.50	67	1.70	127	1.35	40	1.40	47	1.90	217
9	2.10	334	1.50	67	1.65	110	1.35	40	1.40	47	1.90	217
10	2.15	366	1.50	67	1.60	93	1.35	40	1.40	47	2.10	234
11	2.10	334	1.50	67	1.60	93	1.35	40	1.40	47	2.15	366
12	2.05	301	1.50	67	1.60	93	1.35	40	1.40	47	2.20	399
13	2.20	390	1.50	67	1.60	93	1.30	33	1.40	47	2.40	533
14	2.20	390	1.50	67	1.60	93	1.30	33	1.40	47	2.40	533
15	2.10	334	1.50	67	1.60	93	1.30	33	1.40	47	2.50	603
16	2.00	271	1.50	67	1.55	80	1.30	33	1.40	47	2.60	674
17	1.90	217	1.50	67	1.55	80	1.30	33	1.40	47	2.60	674
18	1.85	192	1.45	57	1.55	80	1.30	33	1.40	47	2.60	674
19	1.80	168	1.45	57	1.55	80	1.30	33	1.50	67	2.60	674
20	1.75	147	1.45	57	1.50	67	1.30	33	1.50	67	2.60	674
21	1.70	127	1.45	57	1.50	67	1.30	33	1.50	67	2.60	674
22	1.65	110	1.45	57	1.50	67	1.30	33	1.50	67	2.60	674
23	1.65	110	1.45	57	1.45	57	1.40	47	1.50	67	2.60	674
24	1.60	93	1.45	57	1.45	57	1.40	47	1.50	67	2.70	746
25	1.60	93	1.45	57	1.45	57	1.40	47	1.60	93	2.70	746
26	1.60	93	1.45	57	1.45	57	1.40	47	1.60	93	2.70	746
27	1.55	80	1.40	47	1.40	47	1.40	47	1.60	93	2.70	746
28	1.55	80	1.40	47	1.40	47	1.40	47	1.75	147	2.70	746
29	1.55	80	1.40	47	1.40	47	1.40	47	1.80	168	2.90	896
30	1.75	147	1.40	47	1.35	40	1.40	47	1.80	168	6.80	5710
31	1.65	110	1.40	47	....	..	1.40	47	....	...	5.86	4309

a. Max. 11.90 = 16991 sec.-ft.

Daily Gage Heights and Discharges of Youghiogheny River at Confluence, Pa., for 1911.

Day	January		February		March		April		May	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.20	2125	5.10	3207	3.70	1598	3.10	1055	3.00	974
2	5.00	3077	4.45	2409	3.60	1501	3.05	1014	2.85	858
3	6.10	4610	4.00	1907	3.50	1407	3.00	974	2.75	783
4	5.00	3077	3.85	1750	3.40	1316	3.40	1316	2.65	710
5	4.10	2015	3.75	1648	3.35	1271	7.70	7242	2.65	710
6	3.60	1501	3.65	1549	3.40	1316	9.50	10555	2.55	638
7	3.25	1183	3.45	1361	3.40	1316	6.35	4992	2.45	568
8	3.00	974	3.30	1226	3.45	1361	5.15	3272	2.40	533
9	2.80	820	3.40	1316	3.45	1361	5.05	3142	2.35	499
10	2.70	746	3.25	1182	3.50	1407	5.00	3077	2.30	465
11	2.90	896	3.15	1097	3.40	1316	4.45	2409	2.25	432
12	3.20	1139	3.05	1014	3.40	1316	4.00	1907	2.20	399
13	12.40	16046	3.05	1014	3.30	1226	3.70	1598	2.15	366
14	8.60	8884	3.35	1271	3.40	1316	3.65	1549	2.15	366
15	7.20	6375	4.00	1907	3.80	1698	4.20	2125	2.10	334
16	5.80	4166	3.65	1549	3.70	1598	4.00	1907	2.10	334
17	4.75	2766	3.45	1361	3.65	1549	3.80	1698	2.05	304
18	4.00	1907	3.20	1139	3.60	1501	3.70	1598	2.05	304
19	3.55	1454	3.00	974	3.75	1648	3.60	5101	2.00	271
20	3.30	1226	2.90	896	4.90	2951	4.00	1907	2.00	271
21	3.20	1139	2.80	820	4.40	2351	3.00	974	2.00	271
22	3.20	1139	2.70	746	4.10	2015	4.05	1961	2.00	271
23	3.15	1097	2.70	746	3.90	1801	4.55	2526	2.00	271
24	3.10	1055	2.75	783	3.75	1648	4.15	2070	2.25	432
25	3.05	1014	2.85	858	3.60	1501	3.95	1854	2.15	366
26	3.30	1226	3.20	1139	3.50	1407	3.75	1648	2.05	304
27	4.80	2827	4.00	1907	3.40	1316	3.50	1407	1.95	244
28	4.90	2951	3.85	1750	3.35	1271	3.30	1226	1.90	217
29	5.55	3811	....	....	3.30	1226	3.15	1097	1.90	217
30	12.75	16703	....	....	3.30	1226	3.00	974	2.10	334
31	7.15	6291	....	....	3.20	1139	....	....	2.10	334

Estimated Monthly Discharge of Youghiogheny River at Confluence, Pa.

[Drainage area, 435 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
October	124	28	54	0.124	0.143
November	50	35	45	0.103	0.114
December	2990	50	503	1.156	1.333
1905					
January	5040	308	791	1.818	2.096
March	10500	910	3809	8.756	10.095
April	1847	595	932	2.143	2.391
May	1952	250	696	1.600	1.845
June	2710	308	893	2.053	2.290
July	2850	279	1007	2.315	2.669
August	2460	250	696	1.600	1.845
September	1647	94	445	1.023	1.141
October	4760	81	666	1.531	1.765
November	3700	250	620	1.425	1.589
December	7420	370	1401	3.221	3.713

Estimated Monthly Discharge of Youghiogheny River at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1906					
January	10150	595	1792	4.200	4.842
February	711	202	408	0.938	0.977
March	8190	595	1684	3.871	4.463
April	5950	1080	2356	5.416	6.043
May	1250	160	533	1.225	1.412
June	3417	279	813	1.869	2.085
July	830	124	275	0.632	0.728
August	7630	202	1238	2.846	3.281
September	250	94	156	0.359	0.401
October	518	140	271	0.623	0.718
November	2340	140	526	1.209	1.349
December	7490	441	2252	5.177	5.968
The year	10150	94	1025	2.364	32.267
1907					
January	13860	750	4150	9.540	10.999
February	5040	672	1256	2.887	3.006
March	22650	633	3981	9.152	10.551
April	3558	370	1121	2.577	2.875
May	7700	711	1470	3.379	3.896
June	3913	370	1473	3.386	3.778
July	5390	202	1553	3.570	4.116
August	1900	202	678	1.559	1.798
September	711	180	359	0.825	0.920
October	1250	180	453	1.041	1.200
November	5600	339	1543	3.547	3.958
December	6300	479	2261	5.198	5.993
The year	22650	180	1692	3.888	53.090
1908					
January	5180	556	1451	3.336	3.846
February	17150	633	2023	4.650	5.015
March	11550	750	3892	8.947	10.315
April	6300	518	1742	4.005	4.468
May	10500	595	2762	6.350	7.321
June	952	94	321	0.738	0.824
July	556	70	152	0.349	0.403
August	479	50	114	0.262	0.302
September	70	23	42	0.097	0.108
October	35	28	31	0.071	0.082
November	50	35	39	0.090	0.100
December	830	28	146	0.336	0.387
The year	17150	23	1060	2.436	33.171
1909					
January	2920	140	763	1.754	2.022
February	7490	405	1910	4.391	4.572
March	2580	633	1377	3.166	3.650
April	6230	790	1916	4.404	4.913
May	1695	250	677	1.555	1.793
June	3629	250	1342	3.085	3.442
July	370	70	139	0.320	0.369
August	1420	50	287	0.660	0.761
September	595	94	177	0.407	0.454
October	3135	50	353	0.811	0.935
November	308	160	220	0.506	0.565
December	1335	160	353	0.811	0.935
The year	7490	50	793	1.822	24.411

Estimated Monthly Discharge of Youghiogheny River at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	16991	432	2879	6.618	7.630
February	6460	271	1752	4.028	4.195
March	6123	244	1209	2.779	3.204
April	3811	168	646	1.485	1.656
May	1014	399	608	1.397	1.611
June	15668	499	2109	4.848	5.405
July	432	80	239	0.549	0.633
August	93	47	63	0.145	0.167
September	366	40	104	0.239	0.267
October	47	33	39	0.089	0.156
November	168	47	68	0.156	0.173
December	5710	168	787	1.809	2.086
The year	16991	33	875	2.012	27.183
1911					
January	16703	746	3363	7.731	8.913
February	3207	746	1376	3.163	3.294
March	2951	1139	1512	3.476	4.008
April	10555	974	2352	5.407	6.033
May	974	217	432	0.993	1.145

YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD.

This station, situated on the iron highway bridge at Friendsville, Garrett Co., Md., 86 miles above the mouth, was established August 17, 1898, by E. G. Paul, for the U. S. Geological Survey. The station was discontinued December 31, 1904.

A standard chain gage, measuring 20 feet from the marker to bottom of weight, was installed at this station.

Measurements were taken from upstream side of bridge. The initial point for soundings was 15 feet back from face of the right abutment on upstream side of bridge.

The zero of the gage was 33.17 feet below the U. S. Geological Survey bench mark on the foundation corner stone of the southeast corner of Friend's store. The elevation of the bench mark is 1501.53 feet.

The channel is straight for several hundred feet above and below the station. The bed is rocky and the banks are high and not subject to overflow.

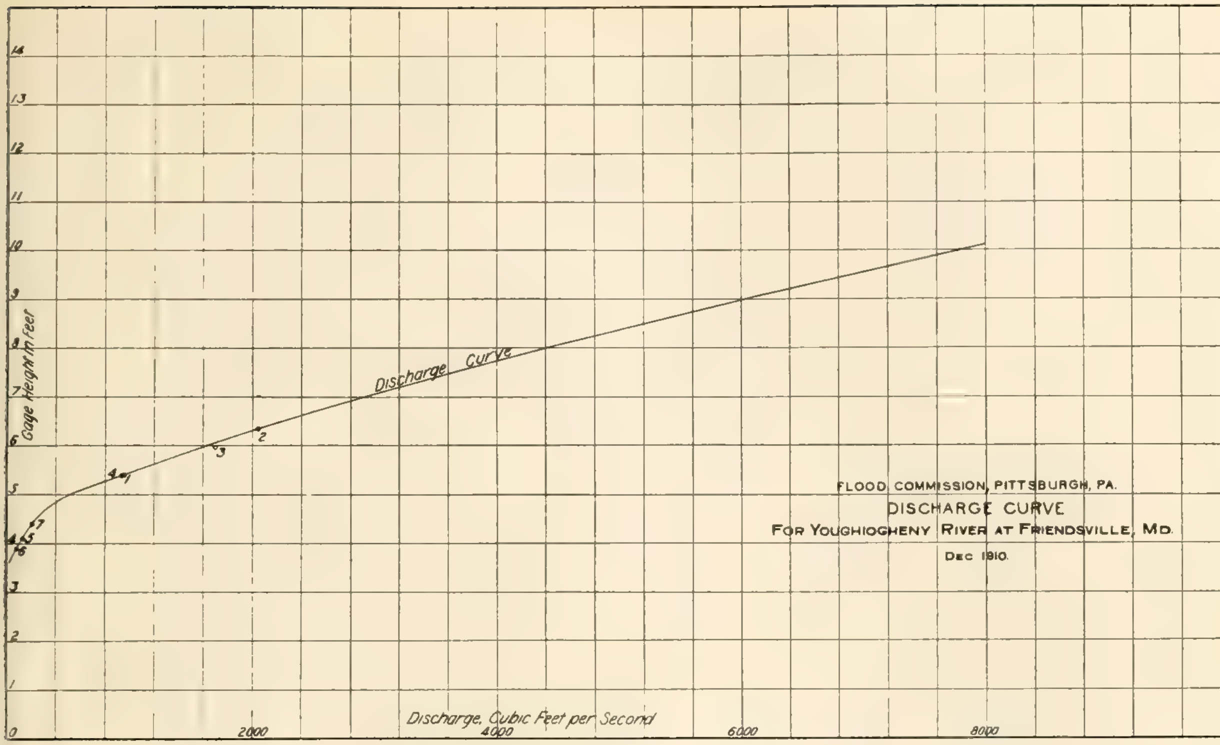
The drainage area above the station is 294 square miles.

Discharge Measurements of Youghiogheny River at Friendsville, Md.

Date	Hydrographer	Gage Height	Discharge
1899		*Feet*	*Sec.-ft.*
Jan. 24	U. S. Geological Survey	5.40	959
Jan. 25	do	6.35	2050
May 17	do	5.97	1697
June 30	do	5.40	944
1901			
July 27	do	4.10	132
Nov. 3	do	3.90	89
1902			
Aug. 22	do	4.40	208
1903			
Sept. 3	do	4.10	124

Note: More measurements have been made by F. W. Scheidenhelm and discharge curve is based on these measurements as well as on above. Mr. Scheidenhelm's data on individual measurements are not available.

PLATE 111



Rating Table for Youghiogheny River at Friendsville, Md.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
3.60	22	5.00	625	6.40	2125	7.80	4100	9.20	6370
.70	35	.10	710	.50	2250	.90	4250	.30	6540
.80	51	.20	795	.60	2380	8.00	4400	.40	6720
.90	71	.30	885	.70	2510	.10	4560	.50	6900
4.00	95	.40	980	.80	2645	.20	4720	.60	7080
.10	124	.50	1080	.90	2780	.30	4880	.70	7260
.20	158	.60	1180	7.00	2920	.40	5040	.80	7440
.30	197	.70	1285	.10	3060	.50	5200	.90	7620
.40	241	.80	1395	.20	3200	.60	5360	10.00	7800
.50	290	.90	1510	.30	3350	.70	5520	.10	7980
.60	345	6.00	1630	.40	3500	.80	5690	.20	8160
.70	405	.10	1750	.50	3650	.90	5860	...	....
.80	470	.20	1875	.60	3800	9.00	6030	...	....
.90	545	.30	2000	.70	3950	.10	6200	...	....

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1899.

Day	January		February		March		April		May		June	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.20	795	5.00	625	6.50	2250	6.50	2250	4.60	345	4.90	545
2	5.20	795	4.90	545	6.40	2125	6.30	2000	5.00	625	4.90	545
3	5.20	795	5.00	625	6.30	2000	6.00	1630	5.20	795	4.80	470
4	5.40	980	7.40	3500	6.30	2000	5.80	1395	5.30	885	4.80	470
5	6.50	2250	7.00	2920	7.70	3950	5.30	885	5.30	885	4.80	470
6	6.30	2000	6.20	1875	8.20	4720	5.20	795	5.20	795	4.60	345
7	6.10	1750	5.90	1510	6.60	2380	5.10	710	5.20	795	4.50	290
8	6.00	1630	5.60	1180	6.20	1875	6.90	2780	5.10	710	4.50	290
9	5.80	1395	5.40	980	5.90	1510	6.50	2250	6.90	2780	4.40	241
10	5.60	1180	5.30	885	6.30	2000	5.90	1510	6.50	2250	5.20	795
11	5.30	885	5.20	795	6.10	1750	5.70	1285	6.30	2000	5.90	1510
12	5.20	795	5.10	710	6.00	1630	5.50	1080	5.90	1510	5.80	1395
13	5.10	710	5.10	710	5.90	1510	5.30	885	5.60	1180	5.60	1180
14	6.10	1750	a5.10	710	5.70	1285	5.20	795	5.60	1180	5.60	1180
15	8.00	4400	5.10	710	5.60	1180	5.10	710	5.50	1080	5.70	1285
16	7.10	3060	5.10	710	5.60	1180	5.10	710	5.60	1180	6.50	2250
17	6.80	2645	5.10	710	5.70	1285	5.00	625	5.70	1285	6.20	1875
18	6.50	2250	5.10	710	5.70	1285	5.00	625	8.00	4400	5.40	980
19	6.20	1875	5.10	710	5.70	1285	5.00	625	9.50	6900	5.00	625
20	5.80	1395	5.20	795	5.70	1285	4.90	545	7.20	3200	4.80	470
21	5.50	1080	5.40	980	6.00	1630	4.90	545	6.90	2780	4.80	470
22	5.40	980	6.80	2645	6.00	1630	4.80	470	6.50	2250	4.70	405
23	5.30	885	7.20	3200	6.30	2000	4.70	405	6.10	1750	4.60	345
24	5.30	885	6.40	2125	6.30	2000	4.70	405	5.60	1180	4.50	290
25	6.40	2125	5.90	1510	6.00	1630	4.70	405	5.30	885	5.30	885
26	6.00	1630	6.20	1875	5.80	1395	4.60	345	5.10	710	5.10	710
27	5.70	1285	7.90	4250	5.60	1180	4.60	345	4.90	545	5.20	795
28	5.50	1080	7.20	3200	6.60	2380	4.70	405	4.90	545	5.20	795
29	5.30	885	....	....	8.00	4400	4.70	405	4.80	470	5.40	980
30	5.10	710	....	....	7.30	3350	4.60	345	4.90	545	5.60	1180
31	5.10	710	....	....	6.90	2780	....	...	4.90	545	....	....

Day	July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.20	795	4.50	290	4.00	95	4.10	124	4.10	124	4.30	197
2	4.80	470	4.30	197	4.10	124	4.10	124	4.60	345	4.30	197
3	4.60	345	4.20	158	4.00	95	4.10	124	5.00	625	4.30	197
4	4.40	241	4.20	158	4.00	95	4.10	124	4.80	470	4.30	197
5	4.60	345	4.60	345	3.90	71	4.00	95	4.50	290	4.30	197
6	4.50	290	4.80	470	3.90	71	4.00	95	4.50	290	4.50	290
7	4.50	290	4.50	290	3.90	71	4.00	95	4.40	241	4.60	345
8	4.50	290	4.30	197	4.10	124	4.00	95	4.30	197	4.60	345
9	4.40	241	4.20	158	4.00	95	4.00	95	4.30	197	4.80	470
10	4.40	241	4.20	158	4.40	241	4.00	95	4.40	241	4.90	545
11	4.30	197	4.30	197	4.40	241	3.90	71	4.30	197	4.90	545
12	4.20	158	4.20	158	4.30	197	3.90	71	4.20	158	5.40	980
13	4.20	158	4.20	158	4.30	197	3.90	71	4.20	158	5.80	1395
14	4.30	197	4.20	158	4.20	158	3.90	71	4.20	158	5.50	1080
15	4.40	241	4.10	124	4.10	124	3.90	71	4.20	158	5.30	885
16	4.60	345	4.10	124	4.10	124	3.90	71	4.10	124	5.10	710
17	4.60	345	4.10	124	4.00	95	3.90	71	4.10	124	5.10	710
18	4.90	545	4.00	95	4.00	95	3.90	71	4.10	124	5.20	795
19	4.70	405	4.00	95	4.10	124	3.90	71	4.30	197	5.40	980
20	4.50	290	4.00	95	4.10	124	3.90	71	4.40	241	5.40	980
21	4.40	241	4.00	95	4.30	197	3.90	71	4.60	345	5.30	885
22	4.30	197	4.00	95	4.20	158	3.90	71	4.70	405	5.30	885
23	4.20	158	4.00	95	4.20	158	3.90	71	4.60	345	5.30	885
24	4.20	158	4.00	95	4.10	124	3.90	71	4.60	345	5.20	795
25	4.40	241	4.00	95	4.00	95	3.90	71	4.60	345	5.20	795
26	4.20	158	4.00	95	4.00	95	3.90	71	4.40	241	5.20	795
27	4.20	158	4.00	95	4.10	124	3.90	71	4.40	241	5.10	710
28	4.20	158	4.00	95	4.10	124	4.00	95	4.40	241	5.10	710
29	4.40	241	4.10	124	4.10	124	4.00	95	4.40	241	5.10	710
30	4.30	197	4.10	124	4.10	124	4.00	95	4.30	197	5.10	710
31	4.30	197	4.00	95	....	...	4.00	95	....	...	5.10	710

a. Frozen February 14 to 18, inclusive.

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1900.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.10	710	4.80	470	6.30	2000	5.80	1395	4.60	345	4.30	197	4.80	470	4.70	405	4.00	95	3.90	71	4.10	124	5.30	885
2	5.10	710	4.80	470	6.80	2645	5.80	1395	4.60	345	4.30	197	4.80	470	4.50	290	4.00	95	3.90	71	4.10	124	5.20	795
3	5.10	710	4.80	470	6.60	2380	5.80	1395	4.50	290	4.30	197	4.70	405	4.30	197	4.00	95	3.90	71	4.10	124	5.10	710
4	5.10	710	4.80	470	6.30	2000	5.60	1180	4.50	290	4.40	241	4.80	470	4.20	158	4.00	95	3.90	71	4.40	241	5.30	885
5	5.10	710	4.80	470	6.20	1875	5.50	1080	4.50	290	4.30	197	4.60	345	4.20	158	4.00	95	3.90	71	4.30	197	5.60	1180
6	5.10	710	5.40	980	6.30	2000	5.50	1080	4.60	345	4.30	197	4.40	241	4.20	158	4.00	95	3.90	71	4.20	158	5.80	1395
7	5.20	795	5.60	1180	6.10	1750	5.50	1080	4.60	345	4.20	158	4.30	197	4.10	124	4.00	95	3.90	71	4.20	158	7.50	3650
8	5.30	885	6.60	2380	6.00	1630	5.40	980	4.70	405	4.20	158	4.30	197	4.10	124	3.90	71	3.90	71	4.20	158	7.30	3350
9	5.30	885	6.80	2645	5.80	1395	5.40	980	4.70	405	4.20	158	4.30	197	4.00	95	3.90	71	3.90	71	4.40	241	6.90	2780
10	5.30	885	6.60	2380	5.70	1285	5.30	885	4.60	345	4.20	158	4.20	158	4.00	95	3.90	71	3.90	71	4.30	197	6.40	2125
11	5.40	980	6.40	2125	5.60	1180	5.30	885	4.50	290	4.10	124	4.20	158	4.00	95	3.90	71	3.90	71	4.30	197	6.10	1750
12	6.30	2000	6.20	1875	5.50	1080	5.20	795	4.60	345	4.10	124	4.10	124	4.00	95	3.90	71	3.90	71	4.30	197	5.80	1395
13	6.30	2000	6.30	2000	5.30	885	5.10	710	4.70	405	4.20	158	4.10	124	4.00	95	3.90	71	3.90	71	4.30	197	5.60	1180
14	6.00	1630	6.40	2125	5.30	885	5.00	625	4.70	405	4.50	290	4.10	124	4.00	95	3.90	71	4.10	124	4.30	197	5.40	980
15	5.80	1395	6.30	2000	5.30	885	5.00	625	4.80	470	4.70	405	4.10	124	4.10	124	3.90	71	4.30	197	4.20	158	5.40	980
16	5.80	1395	6.10	1750	5.40	980	4.90	545	4.90	545	4.40	241	4.10	124	4.20	158	3.80	51	4.30	197	4.20	158	5.30	885
17	5.50	1180	5.80	1395	5.30	885	4.90	545	4.90	545	6.70	2510	4.00	95	4.50	290	3.80	51	4.20	158	4.20	158	5.20	795
18	5.50	1180	5.60	1180	5.50	1080	4.80	470	4.80	470	7.10	3060	4.00	95	4.50	290	3.80	51	4.20	158	4.30	197	5.10	710
19	5.50	1180	5.20	795	5.70	1285	4.80	470	4.70	405	7.00	2920	4.00	95	4.40	241	3.80	51	4.20	158	4.40	241	4.90	545
20	5.70	1285	5.10	710	5.90	1510	4.70	405	4.70	405	6.50	2250	4.10	124	4.30	197	3.80	51	4.10	124	4.40	241	4.70	405
21	6.00	1630	5.10	710	7.00	2920	4.70	405	4.70	405	6.00	1630	4.10	124	4.20	158	3.80	51	4.20	158	4.50	290	4.60	345
22	6.30	2000	5.00	625	6.50	2250	4.70	405	4.70	405	5.30	885	4.20	158	4.20	158	3.80	51	4.20	158	4.70	405	4.60	345
23	6.10	1750	5.00	625	6.10	1750	4.60	345	4.70	405	4.80	470	4.30	197	4.60	345	3.80	51	4.10	124	4.80	470	4.50	290
24	5.70	1285	5.00	625	5.80	1395	4.60	345	4.60	345	4.70	405	4.30	197	4.20	158	3.80	51	4.00	95	4.90	545	4.30	197
25	5.50	1080	5.00	625	5.60	1180	4.70	405	4.50	290	4.70	405	4.40	241	4.30	197	3.80	51	4.00	95	5.20	795	4.30	197
26	5.40	980	5.00	625	5.50	1080	4.70	405	4.40	241	4.60	345	4.70	405	4.30	197	3.80	51	4.00	95	9.50	6900	4.40	241
27	5.30	885	5.10	710	5.40	980	4.80	470	4.40	241	4.50	290	5.00	625	4.10	124	3.90	71	4.10	124	8.30	4880	4.60	345
28	5.20	795	5.10	710	5.40	980	4.80	470	4.40	241	4.60	345	4.60	345	4.10	124	3.90	71	4.20	158	6.90	2780	4.80	470
29	5.00	625	....	...	5.50	1080	4.70	405	4.40	241	4.80	470	4.70	405	4.20	158	3.90	71	4.10	124	5.80	1395	5.00	625
30	5.00	625	....	...	5.70	1285	4.70	405	4.40	241	4.90	545	4.90	545	4.10	124	3.90	71	4.10	124	5.50	1080	5.20	795
31	5.00	625	....	...	5.70	1285	....	...	4.40	241	....	...	5.50	1080	4.10	124	....	..	4.10	124	....	....	5.20	795

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1901.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.00	625	5.00	625	5.00	625	5.30	885	5.50	1080	6.30	2000
2	4.90	545	5.00	625	5.00	625	5.30	885	5.30	885	5.80	1395
3	4.90	545	5.00	625	6.90	2780	5.40	980	5.20	795	5.40	980
4	4.90	545	5.00	625	6.70	2510	5.90	1510	5.00	625	5.20	795
5	4.90	545	5.00	625	6.50	2250	6.20	1875	5.00	625	5.00	625
6	4.90	545	5.00	625	6.40	2125	7.50	3650	4.90	545	5.20	795
7	4.90	545	5.00	625	6.10	1750	8.40	5040	4.70	405	5.20	795
8	4.90	545	5.00	625	5.70	1285	8.00	4400	4.60	345	5.80	1395
9	4.90	545	5.00	625	6.40	2125	7.00	2920	4.80	470	5.60	1180
10	5.20	795	5.00	625	8.50	5200	6.60	2380	5.00	625	5.20	795
11	5.70	1285	5.00	625	8.20	4720	6.50	2250	5.80	1395	5.00	625
12	5.90	1510	5.00	625	7.60	3800	6.40	2125	5.90	1510	4.90	545
13	6.30	2000	5.00	625	7.10	3060	6.30	2000	5.80	1395	4.80	470
14	5.90	1510	5.00	625	6.90	2780	6.30	2000	5.70	1285	4.80	470
15	5.70	1285	5.00	625	6.70	2510	6.30	2000	5.60	1180	5.00	625
16	5.50	1080	5.00	625	6.60	2380	6.10	1750	5.60	1180	5.40	980
17	5.40	980	5.00	625	6.40	2125	6.00	1630	5.50	1080	5.10	710
18	5.10	710	5.00	625	6.20	1875	5.90	1510	5.40	980	5.00	625
19	4.90	545	5.00	625	5.90	1510	5.80	1395	5.20	795	4.90	545
20	4.90	545	5.00	625	5.80	1395	5.90	1510	5.10	710	4.70	405
21	5.30	885	6.00	1630	5.70	1285	7.80	4100	5.00	625	4.70	405
22	5.20	795	5.00	625	5.60	1180	7.50	3650	5.00	625	4.70	405
23	5.20	795	5.00	625	5.50	1080	7.10	3060	5.10	710	4.60	345
24	5.10	710	5.00	625	5.40	980	6.00	1630	5.10	710	4.50	290
25	5.10	710	5.00	625	5.40	980	6.60	2380	5.20	795	4.50	290
26	5.10	710	5.00	625	5.30	885	6.40	2125	5.90	1510	4.40	241
27	5.00	a625	5.00	625	5.30	885	6.10	1750	7.00	2920	4.60	345
28	5.00	625	5.00	625	6.00	1630	6.10	1750	7.30	3350	4.80	470
29	5.00	625	....	...	5.80	1395	5.90	1510	7.10	3060	4.60	345
30	5.00	625	....	...	5.60	1180	5.70	1285	6.80	2645	4.50	290
31	5.00	625	....	...	5.40	980	....	....	6.50	2250	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.40	241	4.00	95	4.10	124	3.90	71	3.90	71	4.40	241
2	4.30	197	4.00	95	4.00	95	3.90	71	3.90	71	4.70	405
3	4.20	158	4.00	95	4.00	95	3.90	71	3.90	71	5.60	1180
4	4.20	158	4.00	95	4.00	95	3.90	71	3.90	71	6.90	2780
5	4.20	158	4.00	95	4.00	95	3.90	71	3.90	71	6.40	2125
6	4.20	158	4.10	124	4.00	95	3.90	71	3.90	71	6.40	2125
7	4.10	124	4.10	124	3.90	71	3.90	71	3.90	71	6.10	1750
8	4.10	124	4.10	124	3.90	71	3.90	71	3.90	71	6.00	1630
9	4.00	95	4.10	124	3.90	71	3.90	71	3.90	71	5.30	885
10	4.00	95	4.00	95	3.90	71	3.60	22	3.90	71	6.30	2000
11	4.00	95	4.00	95	4.10	124	3.90	71	3.90	71	6.00	1630
12	4.10	124	4.10	124	4.10	124	3.90	71	4.00	95	5.80	1395
13	4.10	124	4.20	158	4.20	158	3.90	71	4.00	95	5.40	980
14	4.10	124	4.30	197	4.30	197	3.90	71	4.10	124	7.30	3350
15	4.10	124	4.20	158	4.30	197	4.00	95	4.10	124	9.30	6540
16	4.20	158	4.10	124	4.40	241	4.00	95	4.00	95	7.80	4100
17	5.20	795	4.10	124	4.40	241	4.00	95	4.00	95	7.40	3500
18	5.10	710	4.10	124	4.30	197	4.00	95	4.00	95	6.70	2510
19	4.80	470	4.20	158	4.20	158	4.00	95	4.00	95	5.40	980
20	4.30	197	4.20	158	4.20	158	4.00	95	4.10	124	5.00	625
21	4.20	158	4.20	158	4.10	124	4.00	95	4.20	158	4.90	545
22	4.10	124	4.30	197	4.10	124	4.00	95	4.30	197	4.80	470
23	4.10	124	4.40	241	4.00	95	4.00	95	4.40	241	4.80	470
24	4.20	158	4.60	345	4.00	95	3.90	71	4.40	241	4.80	470
25	4.10	124	4.40	241	4.00	95	3.90	71	4.50	290	4.90	545
26	4.10	124	4.30	197	4.00	95	3.90	71	4.40	241	4.90	545
27	4.10	124	4.20	158	3.90	71	3.90	71	4.40	241	4.90	545
28	4.10	124	4.20	158	3.90	71	3.90	71	4.40	241	4.50	290
29	4.10	124	4.10	124	3.90	71	3.90	71	4.30	197	7.20	3200
30	4.00	95	4.10	124	3.90	71	3.90	71	4.50	290	7.80	4100
31	4.00	95	4.10	124	....	..	3.90	71	....	...	6.70	2510

a. Frozen January 27 to February 2, inclusive.

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1902.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.00	1630	5.60	1180	10.02	8160	5.30	885	4.90	545	5.00	625	6.80	2645	4.50	290	3.90	71	4.20	158	4.20	158	5.80	1395
2	5.80	1395	5.40	980	8.80	5690	5.40	980	4.90	545	4.80	470	6.70	2510	4.60	345	3.90	71	4.20	158	4.20	158	5.80	1395
3	5.40	980	5.20	795	8.10	4560	5.60	1180	4.80	470	4.70	405	6.70	2510	4.90	545	3.90	71	4.30	197	4.20	158	5.90	1510
4	5.40	980	5.10	710	6.30	2000	5.70	1285	4.70	405	4.60	345	6.60	2380	4.80	470	3.90	71	4.40	241	4.10	124	5.90	1510
5	5.30	885	5.00	625	6.10	1750	6.40	2125	4.70	405	4.50	290	6.00	1630	4.50	290	3.80	51	4.30	197	4.10	124	5.80	1395
6	5.20	795	5.00	625	5.90	1510	6.40	2125	4.60	345	4.50	290	5.10	710	4.40	241	3.80	51	4.30	197	4.10	124	5.80	1395
7	5.00	625	5.00	625	5.70	1285	6.50	2250	4.60	345	4.50	290	4.80	470	4.30	197	3.90	71	4.30	197	4.20	158	5.90	1510
8	5.00	625	5.00	625	5.50	1080	6.60	2380	4.60	345	4.50	290	4.60	345	4.30	197	3.90	71	4.20	158	4.20	158	5.70	1285
9	4.90	545	5.00	625	5.40	980	6.60	2380	4.60	345	4.50	290	4.80	470	4.20	158	3.90	71	4.20	158	4.20	158	5.60	1180
10	4.80	470	5.00	625	5.60	1180	6.50	2250	4.60	345	4.40	241	5.00	625	4.20	158	3.90	71	4.40	241	4.20	158	5.60	1180
11	4.80	470	5.00	625	6.20	1875	7.40	3500	4.50	290	4.30	197	4.90	545	4.20	158	3.90	71	4.40	241	4.20	158	5.50	1080
12	4.80	470	5.00	625	7.10	3060	8.20	4720	4.50	290	4.30	197	4.70	405	4.20	158	3.90	71	5.30	885	4.20	158	8.50	5200
13	4.80	470	5.00	625	8.50	5200	7.80	4100	4.50	290	4.50	290	4.50	290	4.10	124	3.80	51	5.30	885	4.20	158	7.90	4250
14	4.80	470	5.00	625	8.10	4560	7.40	3500	4.50	290	4.50	290	4.40	241	4.10	124	3.80	51	5.00	625	4.20	158	7.50	3650
15	4.70	405	5.00	625	7.80	4100	7.10	3060	4.40	241	4.60	345	4.30	197	4.10	124	3.80	51	5.00	625	4.20	158	7.30	3350
16	4.70	405	5.00	625	7.30	3350	6.70	2510	4.40	241	4.70	405	4.30	197	4.10	124	3.80	51	4.70	405	4.20	158	8.20	4720
17	4.70	405	5.00	625	6.90	2780	6.80	2645	4.40	241	4.70	405	4.30	197	4.10	124	3.80	51	4.60	345	4.20	158	8.60	5360
18	4.80	470	5.00	625	6.40	2125	6.80	2645	4.50	290	4.70	405	4.50	290	4.10	124	3.80	51	4.60	345	4.20	158	8.30	4880
19	4.90	545	5.00	625	6.10	1750	6.60	2380	4.80	470	4.60	345	4.70	405	4.20	158	3.80	51	4.50	290	4.20	158	8.00	4400
20	5.00	625	5.00	625	5.90	1510	6.30	2000	4.90	545	4.60	345	4.80	470	4.30	197	3.80	51	4.50	290	4.10	124	7.30	3350
21	5.00	625	5.00	625	5.60	1180	5.80	1395	4.70	405	4.60	345	4.70	405	4.40	241	3.90	71	4.40	241	4.10	124	6.50	2250
22	5.00	625	5.00	625	5.50	1080	5.40	980	4.80	470	4.50	290	4.60	345	4.40	241	3.90	71	4.40	241	4.10	124	6.10	1750
23	5.00	625	5.00	625	5.40	980	5.20	795	5.00	625	4.50	290	4.40	241	4.40	241	3.90	71	4.20	158	4.30	197	6.10	1750
24	5.40	980	5.00	625	5.30	885	5.00	625	5.30	885	4.60	345	4.20	158	4.30	197	3.90	71	4.20	158	4.50	290	6.00	1630
25	5.60	1180	5.00	625	5.20	795	4.80	470	5.60	1180	4.80	470	4.20	158	4.20	158	4.00	95	4.10	124	5.40	241	6.00	1630
26	7.10	3060	7.40	3500	5.10	710	4.70	405	5.70	1285	4.80	470	4.20	158	4.00	95	4.00	95	4.10	124	6.20	1875	5.90	1510
27	7.30	3350	6.50	2250	5.10	710	4.70	405	5.80	1395	4.90	545	4.40	241	4.00	95	4.00	95	4.20	158	6.00	1630	5.80	1395
28	6.90	2780	7.30	3350	5.00	625	4.70	405	5.80	1395	4.70	405	4.50	290	3.90	71	4.00	95	4.40	241	6.00	1630	5.50	1080
29	6.30	2000	....	....	5.10	710	4.80	470	5.30	885	4.90	545	4.60	345	3.90	71	4.00	95	4.40	241	6.00	1630	5.30	885
30	6.00	1630	....	....	5.10	710	4.90	545	5.30	885	5.70	1285	4.50	290	3.90	71	4.00	95	4.50	290	6.00	1630	5.20	795
31	5.80	1395	....	....	5.10	710	....	...	5.20	795	....	....	4.50	290	3.90	71	....	..	4.30	197	....	...	5.10	710

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1903.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.00	625	7.80	4100	7.50	3650	5.20	795	4.80	470	5.20	795
2	6.00	1630	7.50	3650	7.00	2920	5.30	885	4.90	545	5.20	795
3	6.80	2645	7.40	3500	6.50	2250	5.20	795	4.90	545	5.20	795
4	7.80	4100	8.00	4400	6.10	1750	5.20	795	4.90	545	5.30	885
5	6.90	2780	8.00	4400	5.80	1395	5.20	795	4.90	545	5.30	885
6	6.30	2000	7.00	2920	5.80	1395	5.30	885	4.80	470	5.40	980
7	5.90	1510	6.20	1875	5.80	1395	5.50	1080	4.70	405	5.50	1080
8	5.40	980	6.00	1630	5.90	1510	5.80	1395	4.70	405	5.50	1080
9	5.00	625	6.00	1630	6.00	1630	7.00	2920	4.50	290	5.10	710
10	5.20	795	5.80	1395	6.00	1630	6.80	2645	4.50	290	4.80	470
11	5.80	1395	5.20	795	6.20	1875	6.40	2125	4.40	241	5.00	625
12	5.70	1285	5.20	795	7.00	2920	6.00	1630	4.40	241	5.20	795
13	5.50	1080	6.00	1630	7.50	3650	5.60	1180	4.40	241	6.00	1630
14	5.40	980	5.80	1395	6.90	2780	5.60	1180	4.40	241	6.60	2380
15	5.20	795	6.50	2250	6.00	1630	5.60	1180	4.30	197	6.80	2645
16	5.10	710	9.00	6030	5.20	795	5.50	1080	4.30	197	6.70	2510
17	5.00	625	8.50	5200	5.20	795	5.50	1080	4.30	197	6.40	2125
18	5.00	625	6.50	2250	5.20	795	5.50	1080	4.20	158	6.40	2125
19	5.00	625	6.20	1875	5.20	795	5.50	1080	4.20	158	6.20	1875
20	4.90	545	5.90	1510	5.10	710	5.40	980	4.20	158	6.10	1750
21	4.70	405	5.50	1080	5.10	710	5.30	885	4.60	345	6.20	1875
22	4.70	405	5.50	1080	5.80	1395	5.30	885	4.80	470	6.00	1630
23	4.80	470	5.30	885	6.20	1875	5.20	795	5.00	625	6.30	2000
24	4.80	470	5.10	710	8.20	4720	5.00	625	5.20	795	6.40	2125
25	4.90	545	5.00	625	8.00	4400	5.00	625	5.30	885	6.40	2125
26	5.00	625	5.20	795	6.00	1630	4.90	545	5.40	980	6.30	2000
27	5.30	885	5.90	1510	5.80	1395	4.80	470	5.50	1080	7.10	3060
28	5.70	1285	8.00	4400	5.50	1080	4.80	470	5.30	885	7.40	3500
29	7.20	3200	....	....	5.40	980	4.80	470	5.40	980	8.50	5200
30	8.30	4880	....	....	5.40	980	4.70	405	5.30	885	7.90	4250
31	8.00	4400	....	....	5.30	885	....	...	5.20	795	....	....

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.20	1875	4.40	241	4.20	158	3.70	35	3.90	71	4.30	197
2	5.80	1395	4.50	290	4.10	124	3.70	35	3.90	71	4.30	197
3	5.50	1080	4.30	197	4.10	124	3.70	35	4.00	95	4.30	197
4	5.50	1080	4.20	158	4.10	124	4.00	95	4.00	95	4.30	197
5	5.50	1080	4.30	197	4.00	95	4.20	158	4.00	95	4.30	197
6	5.40	980	4.30	197	4.00	95	4.30	197	4.00	95	4.30	197
7	5.30	885	4.30	197	4.00	95	4.50	290	4.00	95	4.30	197
8	5.20	795	4.20	158	4.10	124	4.50	290	4.00	95	4.30	197
9	5.30	885	4.20	158	4.10	124	4.80	470	4.00	95	4.30	197
10	5.40	980	4.10	124	4.10	124	4.60	345	4.00	95	4.30	197
11	5.50	1080	4.10	124	4.00	95	4.50	290	4.00	95	4.30	197
12	5.60	1180	4.10	124	4.00	95	4.30	197	4.20	158	4.30	197
13	5.50	1080	4.10	124	4.00	95	4.30	197	4.60	345	4.30	197
14	5.50	1080	4.10	124	4.00	95	4.20	158	4.70	405	4.30	197
15	5.40	980	4.00	95	4.00	95	4.20	158	4.90	545	4.30	197
16	5.20	795	4.10	124	3.90	71	4.20	158	5.00	625	4.30	197
17	5.10	710	4.10	124	3.90	71	4.30	197	5.60	1180	4.30	197
18	5.20	795	4.20	158	3.90	71	4.20	158	5.20	795	4.30	197
19	5.10	710	4.30	197	3.90	71	4.10	124	4.90	545	4.30	197
20	5.30	885	4.30	197	3.90	71	4.10	124	4.70	405	4.30	197
21	5.20	795	4.20	158	3.80	51	4.10	124	4.60	345	4.30	197
22	5.20	795	4.30	197	3.80	51	4.10	124	4.50	290	4.30	197
23	5.10	710	4.20	158	3.80	51	4.10	124	4.50	290	4.30	197
24	4.90	545	4.10	124	3.80	51	4.00	95	4.40	241	4.30	197
25	4.70	405	4.20	158	3.80	51	4.00	95	4.40	241	4.30	197
26	4.60	345	4.30	197	3.80	51	4.00	95	4.40	241	4.30	197
27	4.50	290	4.40	241	3.80	51	4.00	95	4.30	197	4.30	197
28	4.30	197	4.50	290	3.80	51	4.00	95	4.30	197	4.30	197
29	4.20	158	4.40	241	3.70	35	4.00	95	4.30	197	4.30	197
30	4.20	158	4.30	197	3.70	35	4.00	95	a4.30	197	4.30	197
31	4.30	197	4.20	158	....	..	3.90	71	....	...	4.30	197

a. Readings to top of ice remainder of year.

Daily Gage Heights and Discharges of Youghiogheny River at Friendsville, Md., for 1904.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.30	197	5.40	862	8.00	3766	5.70	1150	5.40	862	4.90	545	4.60	345	4.00	95	3.80	51	3.80	51	3.80	51	3.90	71
2	4.30	197	5.10	600	7.60	3310	5.60	1050	5.30	770	4.90	545	4.50	290	4.00	95	3.80	51	3.80	51	3.80	51	3.90	71
3	4.30	197	5.00	625	6.80	2398	5.50	955	5.30	770	4.90	545	4.50	290	4.00	95	3.80	51	3.80	51	3.80	51	3.90	71
4	4.30	197	4.80	470	6.40	1942	5.50	955	5.30	770	4.90	545	4.40	241	4.00	95	3.80	51	3.80	51	3.80	51	3.90	71
5	4.30	197	4.60	345	6.10	1600	5.30	770	5.20	685	4.80	470	4.50	290	4.10	124	3.80	51	3.80	51	3.80	51	3.90	71
6	4.30	197	4.50	290	6.00	1486	5.10	600	5.10	600	4.80	470	4.40	241	4.00	95	3.80	51	3.80	51	3.80	51	3.90	71
7	4.30	197	6.30	1828	5.90	1372	5.10	600	4.90	545	4.70	405	4.30	197	3.90	71	3.80	51	3.90	71	3.80	51	3.90	71
8	4.30	197	6.00	1486	6.30	1828	5.20	685	4.80	470	4.90	545	4.40	241	3.90	71	3.80	51	3.90	71	3.80	51	3.90	71
9	4.30	197	6.50	2056	6.60	2170	5.10	600	4.80	470	4.80	470	4.50	290	3.90	71	3.80	51	3.90	71	3.80	51	3.90	71
10	4.30	197	6.30	1828	6.40	1942	5.00	625	4.70	405	4.70	405	4.50	290	3.90	71	3.80	51	3.90	71	3.80	51	3.90	71
11	4.30	197	6.20	1714	6.20	1714	5.00	625	4.60	345	4.60	345	4.60	345	3.80	51	3.80	51	3.90	71	3.80	51	3.90	71
12	4.30	197	5.90	1372	5.90	1372	4.90	545	4.60	345	4.50	290	4.50	290	3.80	51	3.80	51	3.90	71	3.80	51	3.90	71
13	4.30	197	5.90	1372	5.70	1150	4.80	470	4.60	345	4.40	241	4.50	290	3.80	51	3.80	51	3.90	71	3.80	51	3.90	71
14	4.30	197	5.90	1372	5.40	862	4.80	470	4.50	290	4.40	241	4.40	241	3.80	51	3.80	51	3.90	71	3.80	51	3.90	71
15	4.30	197	5.90	1372	5.20	685	4.70	405	4.50	290	4.30	197	4.30	197	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
16	4.30	197	5.90	1372	5.00	625	4.80	470	4.40	241	4.30	197	4.20	158	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
17	5.40	862	5.90	1372	4.90	545	4.80	470	4.50	290	4.30	197	4.10	124	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
18	5.90	1372	5.90	1372	4.80	470	4.80	470	5.30	770	4.30	197	4.20	158	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
19	6.30	1828	5.90	1372	5.00	625	4.80	470	6.70	2284	4.30	197	4.00	95	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
20	7.50	3196	5.90	1372	5.20	685	4.70	405	6.80	2398	4.40	241	4.00	95	3.70	35	3.80	51	3.90	71	3.80	51	3.90	71
21	8.20	3994	5.90	1372	5.30	770	4.70	405	6.70	2284	4.50	290	4.00	95	3.80	51	3.80	51	3.90	71	3.80	51	4.60	345
22	8.60	4450	6.40	1942	5.60	1050	4.70	405	6.50	2056	4.50	290	4.00	95	3.80	51	3.80	51	3.90	71	3.90	71	4.80	470
23	9.40	5362	6.20	1714	5.80	1260	4.80	470	6.10	1600	4.70	405	4.10	124	3.80	51	3.80	51	3.90	71	3.90	71	5.90	1372
24	6.70	2284	6.00	1486	5.60	1050	4.80	470	5.80	1260	4.80	470	4.10	124	3.90	71	3.80	51	3.90	71	3.90	71	7.80	3534
25	6.00	1486	6.30	1828	5.70	1150	4.80	470	5.50	955	4.70	405	4.20	158	3.90	71	3.80	51	3.90	71	3.90	71	8.60	4450
26	5.70	1150	6.80	2398	5.90	1372	5.20	685	5.20	685	4.60	345	4.10	124	3.90	71	3.80	51	3.90	71	3.80	51	8.30	4108
27	5.50	955	7.40	3052	6.00	1486	5.60	1050	5.20	685	4.50	290	4.10	124	3.80	51	3.80	51	3.90	71	3.80	51	7.50	3196
28	5.60	1050	7.60	3310	6.30	1828	5.80	1260	5.00	625	4.50	290	4.00	95	3.80	51	3.80	51	3.90	71	3.90	71	6.70	2284
29	5.80	1260	8.20	3994	6.20	1714	5.60	1050	5.00	625	4.60	345	4.00	95	3.80	51	3.80	51	3.90	71	3.90	71	5.90	1372
30	5.70	1150	....	....	6.10	1600	5.40	862	5.00	625	4.70	405	4.00	95	3.80	51	3.80	51	3.90	71	3.90	71	5.40	862
31	5.50	955	....	....	5.90	1372	....	....	5.00	625	....	...	4.10	124	3.80	51	....	..	3.90	71	....	..	5.10	600

Frozen during portions of January, February and December.

Estimated Monthly Discharge of Youghiogheny River at Friendsvville, Md.

[Drainage area, 294 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1899					
January	4400	710	1471	4.999	5.763
February	4250	545	1489	5.060	5.269
March	4720	1180	2028	6.900	7.955
April	2780	345	939	3.192	3.561
May	6900	345	1516	5.150	5.937
June	2250	241	802	2.730	3.046
July	795	158	275	0.935	1.078
August	470	95	156	0.531	0.612
September	241	71	129	0.438	0.489
October	124	71	85	0.289	0.333
November	625	124	254	0.864	0.964
December	1395	197	666	2.265	2.611
The year	6900	71	818	2.779	39.517
1900					
January	2000	625	1104	3.755	4.329
February	2645	470	1183	4.025	4.191
March	2920	885	1477	5.020	5.788
April	1395	345	720	2.414	2.693
May	545	241	354	1.205	1.389
June	545	241	658	2.265	2.527
July	1080	95	282	0.959	1.106
August	405	95	172	0.585	0.674
September	95	51	69	0.235	0.262
October	197	71	110	0.374	0.431
November	6900	124	640	2.175	2.426
December	3650	197	1033	3.518	4.055
The year	6900	51	650	2.211	29.871
1901					
January	2000	545	805	2.739	3.157
February	1630	625	660	2.245	2.338
March	5200	625	1932	6.575	7.580
April	5040	885	2198	7.475	8.339
May	3350	345	1197	4.065	4.687
June	2000	241	672	2.285	2.549
July	795	95	187	0.636	0.733
August	345	95	147	0.500	0.576
September	241	71	114	0.387	0.432
October	95	22	76	0.259	0.300
November	290	71	135	0.459	0.512
December	6540	241	1756	5.965	6.877
The year	6540	22	823	2.799	38.080
1902					
January	3350	405	1030	3.500	4.035
February	3500	625	925	3.145	3.275
March	8160	625	2181	7.425	8.560
April	4720	405	1846	6.275	7.001
May	1395	241	564	1.919	2.210
June	1285	197	392	1.332	1.486
July	2645	158	660	2.245	2.588
August	545	71	189	0.642	0.740
September	95	51	69	0.235	0.262
October	885	124	291	0.990	1.141
November	1875	124	413	1.405	1.567
December	5360	710	2238	7.600	8.762
The year	8160	51	900	3.059	41.627

Estimated Monthly Discharge of Youghiogheny River at Friendsville, Md.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1903					
January	4880	405	1417	4.820	5.557
February	6030	710	2296	7.855	8.175
March	4720	710	1817	6.175	7.119
April	2645	405	1058	3.590	4.005
May	1080	158	492	1.674	1.930
June	5200	470	1823	6.200	6.917
July	1875	158	804	2.732	3.149
August	290	95	175	0.595	0.686
September	158	35	83	0.282	0.315
October	470	35	155	0.527	0.608
November	1180	71	281	0.956	1.067
December	197	197	197	0.670	0.772
The year	6030	35	883	3.006	40.300
1904					
January	5362	197	1113	2.789	3.216
February	3994	290	1571	5.340	5.561
March	3766	470	1458	4.940	5.695
April	1260	405	664	2.258	2.519
May	2398	241	838	2.850	3.286
June	545	197	361	1.228	1.370
July	345	95	192	0.653	0.753
August	124	35	62	0.221	0.255
September	51	51	51	0.174	0.195
October	71	51	67	0.228	0.263
November	71	51	56	0.190	0.212
December	4450	71	775	2.630	3.032
The year	5362	35	601	1.958	26.357

LAUREL HILL CREEK AT CONFLUENCE, PA.

This station, situated on the highway bridge about ¼ mile from the railroad station at Confluence, Somerset Co., Pa., was established September 15, 1904, by E. C. Murphy, for the U. S. Geological Survey. In 1907 the station was taken over by the Water Supply Commission of Pennsylvania, and has since been maintained by that commission.

A standard chain gage measuring 17.44 feet from marker to bottom of weight is fastened to the downstream handrail of the bridge.

Bench Mark No. 1 is a cross on the top of a bolt in the bed-plate of the bridge at the right abutment, and is 14.16 feet above the zero of the gage. Bench Mark No. 2 is a cross on the lower chord of the bridge under the gage box, and is 14.74 feet above the zero of the gage.

Discharge measurements are made from the lower side of the single-span steel bridge. The initial point for soundings is the center of the bridge-pin over the left abutment.

The channel is straight for about 250 feet above and 300 feet below the station. The bed is composed of rough cobblestones and is permanent. At low stages conditions of flow are changeable, owing to the fact that refuse dumped into the creek from a tannery a few feet above the station settles under one end of the bridge. The right bank is low, clean and subject to overflow. The left bank is high and not subject to overflow. There is an extreme range of about 16 feet between high and low water.

The station is located only a few hundred yards above the junction of Laurel Hill Creek and Youghiogheny River. Consequently, backwater from the Youghiogheny affects the discharge at all stages above 3.0 feet. A curve reversing and followed by a tangent at high stages has been developed for the station, and gives fair results, but should be used with caution, as the backwater effect varies with every flood.

The gage is read daily by L. L. Mountain.

The drainage area above the station is 126 square miles.

Discharge Measurements of Laurel Hill Creek at Confluence, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1904			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
July	8	J. C. Hoyt	83	156	0.80	2.14	125
Sept.	12	E. C. Murphy	80	91	0.30	1.78	27
Sept	27	N. C. Grover	84	84	0.19	1.75	16
1905							
Mar.	11	E. C. Murphy	100	293	3.18	3.79	933
Mar.	11	do	100	262	3.45	3.63	903
Mar.	15	N. C. Grover	100	214	2.78	3.05	595
Mar.	16	do	100	220	3.04	3.11	665
Mar.	28	A. H. Horton	98	196	2.89	2.98	568
Apr.	17	do	90	167	1.45	2.45	242
Apr.	22	do	100	228	3.00	3.21	684
June	6	R. H. Bolster	87	114	0.52	1.98	59
Nov.	4	Hanna and Grieve	90	167	1.02	2.30	171
1906							
May	26	U. S. Geological Survey	82	116	0.46	1.96	53
1907							
June	10	A. H. Horton	92	175	1.49	2.52	260
Aug.	15	H. D. Padgett	85	120	0.60	2.07	72
1908							
Feb.	16	F. F. Henshaw	114	595	3.62	6.73	1940
Feb.	17	do	102	275	3.49	3.74	960
Aug.	21	R. H. Bolster	73	81	0.21	1.61	17
1909							
June	12	F. W. Scheidenhelm	102	249	2.94	3.40	733
1911							
July	13	F. E. Langenheim	102	329	2.66	a4.10	875

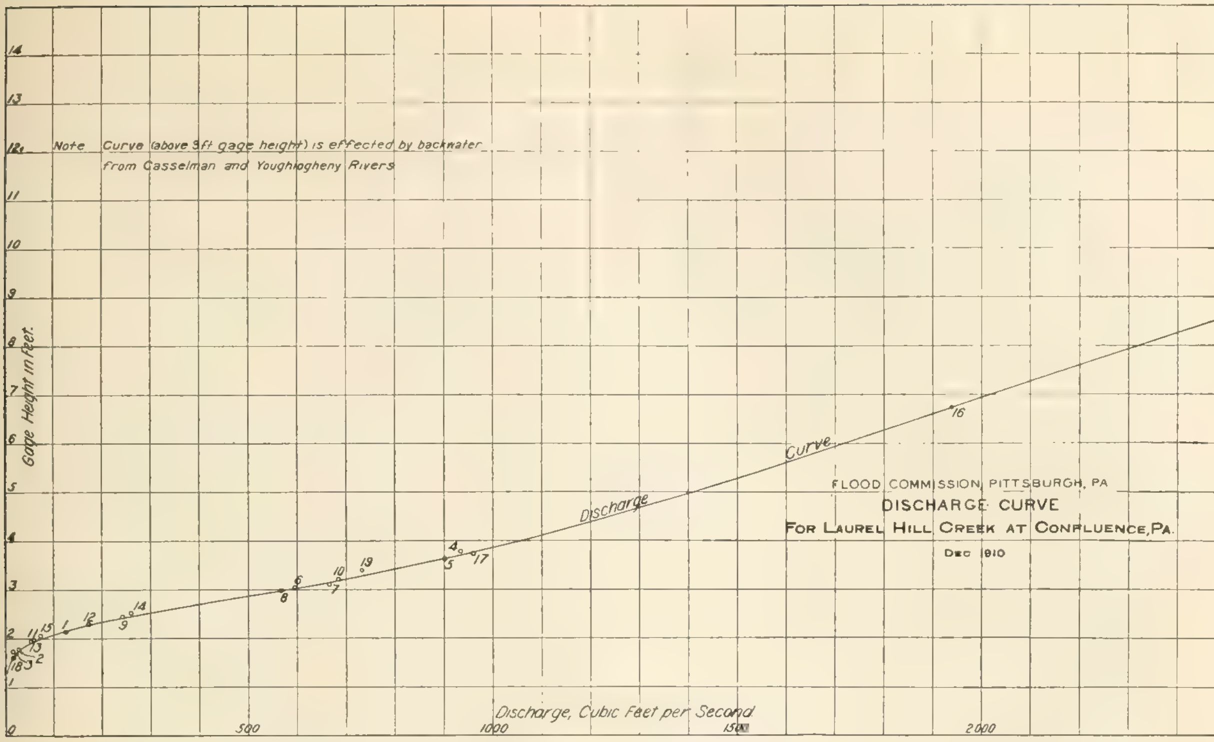
a. No backwater.

Rating Table for Laurel Hill Creek at Confluence, Pa.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.30	4	2.30	185	3.30	742	4.30	1171	5.30	1508
.40	7	.40	232	.40	790	.40	1206	.40	1540
.50	11	.50	284	.50	840	.50	1240	.50	1570
.60	16	.60	338	.60	885	.60	1274	.60	1600
.70	23	.70	395	.70	930	.70	1308	.70	1630
.80	35	.80	456	.80	975	.80	1342	.80	1660
.90	52	.90	522	.90	1020	.90	1376	.90	1690
2.00	76	3.00	581	4.00	1060	5.00	1410	6.00	1720
.10	106	.10	636	.10	1100	.10	1443	...	....
.20	142	.20	690	.20	1136	.20	1476	...	....

Note. This table should be used with caution on account of the station being affected by backwater.

PLATE 112



Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1904.

Day	September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	...	1.65	12	1.60	8	1.70	16
2	....	...	1.65	12	1.60	8	1.70	16
3	....	...	1.60	8	1.60	8	1.70	16
4	....	...	1.60	8	1.60	8	1.70	16
5	....	...	1.60	8	1.60	8	1.70	16
6	....	...	1.60	8	1.60	8	1.70	16
7	....	...	1.60	8	1.65	12	1.70	16
8	....	...	1.65	12	1.65	12	1.70	16
9	....	...	1.65	12	1.65	12	1.70	16
10	....	...	1.65	12	1.65	12	1.70	16
11	....	...	1.80	26	1.65	12	a1.70	16
12	....	...	1.80	26	1.65	12	1.75	21
13	....	...	1.80	26	1.65	12	1.75	21
14	....	...	1.75	21	1.65	12	1.75	21
15	....	...	1.70	16	1.65	12	1.80	26
16	1.80	26	1.70	16	1.65	12	1.80	26
17	1.80	26	1.70	16	1.70	16	1.80	26
18	1.70	16	1.65	12	1.70	16	1.85	33
19	1.65	12	1.60	8	1.70	16	1.85	33
20	1.65	12	1.60	8	1.70	16	1.85	33
21	1.70	16	1.60	8	1.70	16	1.85	33
22	1.70	16	1.60	8	1.70	16	1.85	33
23	1.65	12	1.60	8	1.70	16	1.90	41
24	1.65	12	1.60	8	1.70	16	b3.00	560
25	1.65	12	1.70	16	1.70	16	3.35	760
26	1.65	12	1.70	16	1.70	16	2.70	365
27	1.75	21	1.65	12	1.70	16	3.40	785
28	1.75	21	1.65	12	1.70	16	3.60	885
29	1.70	16	1.65	12	1.70	16	3.00	560
30	1.65	12	1.60	8	1.70	16	2.50	260
31	...	....	1.60	8	...	....	2.40	210

a. River frozen Dec. 11 to 23. b. Ice gone out.

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1905.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec. ft	Feet	Sec.-ft.
1	2.30	170	....	...	2.85	460	2.45	235	2.45	235	2.05	78
2	2.30	170	....	...	....	...	2.35	190	2.40	210	2.05	78
3	2.50	260	....	...	....	...	2.30	170	2.35	190	2.00	62
4	2.45	235	2.25	150	2.85	460	2.30	170	2.35	190	2.00	62
5	2.45	235	....	...	....	...	2.35	190	2.45	235	2.00	62
6	2.40	210	....	...	....	...	2.40	210	2.40	210	1.90	41
7	2.25	150	....	...	....	...	2.45	235	2.30	170	2.70	365
8	2.15	113	2.90	495	3.65	910	2.45	235	2.25	150	2.50	260
9	2.05	78	....	...	4.85	1370	2.40	210	2.15	113	2.40	210
10	2.00	62	....	...	5.20	1476	2.45	235	2.15	113	2.30	170
11	2.05	78	2.85	460	3.85	1010	2.90	495	2.20	130	4.45	1275
12	2.25	150	....	...	3.20	680	2.90	495	2.55	285	3.70	935
13	3.70	935	....	...	3.20	680	2.70	365	2.45	235	3.10	625
14	3.30	735	....	...	3.15	650	2.60	310	2.95	525	2.75	395
15	3.00	560	2.90	495	3.05	595	2.50	260	3.00	560	2.50	260
16	2.65	337	....	...	3.15	650	2.50	260	2.80	425	2.40	210
17	2.60	310	....	...	4.00	1075	2.40	210	2.60	310	2.30	170
18	2.50	260	2.85	460	4.50	1295	2.40	210	2.50	260	2.20	130
19	2.35	190	....	...	7.65	2218	2.40	210	2.40	210	2.15	113
20	2.35	190	....	...	6.55	1888	2.50	260	2.40	210	2.15	113
21	2.30	170	....	...	7.95	2309	2.65	337	2.30	170	2.10	95
22	2.25	150	2.90	495	5.20	1476	3.15	650	2.25	150	4.60	1335
23	2.30	170	....	...	3.75	960	2.80	425	2.20	130	3.80	985
24	2.30	170	....	...	3.30	735	2.65	337	2.15	113	3.85	1010
25	2.20	130	2.85	460	3.50	835	2.60	310	2.15	113	3.40	785
26	2.25	150	....	...	3.20	680	2.50	260	2.10	95	3.20	680
27	....	...	....	...	3.10	625	2.60	310	2.15	113	2.85	460
28	....	...	....	...	2.95	525	2.90	495	2.15	113	2.60	310
29	....	...	....	...	2.70	365	2.65	337	2.10	95	2.45	235
30	....	...	....	...	2.60	310	2.55	285	2 15	113	2.35	190
31	....	...	....	...	2.50	260	....	...	2 05	78	....	...

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.	Feet	Sec.-ft.
1	2.35	190	2.80	425	2.15	113	1.80	26	2.40	210	3.15	650
2	2.45	235	2.50	260	2.10	95	1.80	26	2.30	170	3.00	560
3	2.30	170	2.35	190	2.10	95	2.10	95	2.30	170	6.85	1980
4	2.25	150	2.40	210	2.10	95	1.95	51	2.30	170	4.05	1095
5	2.20	130	2.30	170	2.25	150	1.85	33	2.40	210	3.30	735
6	2.20	130	2.25	150	2.30	170	1.75	21	2.40	210	2.95	525
7	2.20	130	2.25	150	2.30	170	1.70	16	2.35	190	2.75	395
8	2.30	170	1.90	41	2.60	310	1.70	16	2.35	190	2.65	337
9	2.15	113	1.90	41	2.80	425	1.70	16	2.30	170	2.55	285
10	2.30	170	1.85	33	2.90	495	1.65	12	2.25	150	2.45	235
11	2.20	130	2.80	425	4.15	1145	2.30	170	2.20	130	2.45	235
12	2.20	130	2.55	285	3.10	625	2.40	210	2.20	130	2.40	210
13	2.30	170	2.30	170	2.90	495	2.15	113	2.20	130	2.40	210
14	2.20	130	2.30	170	2.55	285	2.05	78	2.20	130	2.35	190
15	2.15	113	4.00	1075	2.40	210	1.95	51	2.15	113	2.35	190
16	2.05	78	4.30	1210	2.30	170	1.90	41	2.25	150	2.30	170
17	2.00	62	3.35	760	2.20	130	1.85	33	2.25	150	2.25	150
18	2.00	62	2.90	495	2.15	113	1.80	26	2.20	130	2.25	150
19	1.90	41	2.60	310	2.00	95	2.20	130	2.20	130	2.20	130
20	2.45	235	2.35	190	2.05	78	4.10	1120	2.15	113	2.15	113
21	2.20	130	2.30	170	2.00	62	3.15	650	2.10	95	3.50	835
22	2.10	95	2.30	170	1.95	51	2.65	337	2.10	95	3.50	835
23	2.00	62	2.20	130	1.90	41	2.50	260	2.05	78	3.20	680
24	2.40	210	2.10	95	1.90	41	2.40	210	2.10	95	2.95	525
25	2.20	130	2.35	190	1.90	41	2.35	190	2.05	78	2.75	395
26	2.15	113	2.20	130	1.85	33	2.65	337	2.05	78	2.65	337
27	2.10	95	2.10	95	1.80	26	2.50	260	2.00	62	2.55	285
28	2.05	78	2.05	78	1.80	26	2.45	235	2.50	260	2.50	260
29	2.30	170	2.00	62	1.80	26	2 35	190	4.75	1395	3.10	625
30	2.40	210	2.30	170	1.80	26	2.35	190	3.90	1030	2.75	395
31	3.25	705	2.20	130	....	...	2.30	170	....	...	2.60	310

Note. Creek frozen January 27 to March 7, inclusive. Gage readings to surface of ice. Thickness of ice 0.7 to 1.0 foot.

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1906.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.55	285	2.30	170	2.50	260	3.60	885	2.30	170	2.10	95	1.95	51	1.85	33	2.05	78	1.95	51	1.80	26	2.30	170
2	2.45	235	2.25	150	2.50	260	3.30	735	2.50	260	2.05	78	1.90	41	1.85	33	2.05	78	2.10	95	1.80	26	2.30	170
3	2.70	365	2.25	150	2.50	260	3.40	785	2.60	310	1.95	51	1.85	33	2.00	62	2.10	95	2.00	62	1.80	26	2.50	260
4	4.00	1075	2.30	170	2.60	310	3.50	835	2.40	210	1.85	33	1.90	41	2.00	62	2.00	62	1.90	41	1.80	26	2.40	210
5	3.20	680	2.30	170	2.50	260	3.80	985	2.35	190	1.80	26	1.85	33	1.90	41	1.90	41	2.00	62	1.80	26	2.35	190
6	2.85	460	2.25	150	2.50	260	4.60	1335	2.30	170	3.20	680	1.80	26	1.80	26	1.90	41	2.10	95	1.75	21	3.90	1030
7	2.65	337	2.25	150	2.50	260	3.50	835	2.30	170	3.50	835	1.80	26	4.00	1075	1.85	33	2.30	170	1.75	21	3.65	910
8	2.70	365	2.20	130	2.50	260	3.15	650	2.25	150	3.00	560	1.80	26	3.80	985	1.80	26	2.10	95	1.75	21	2.90	495
9	2.50	260	2.20	130	2.50	260	3.30	735	2.35	190	2.50	260	1.80	26	4.80	1344	1.80	26	1.95	51	1.75	21	2.70	365
10	2.30	170	2.25	150	2.40	210	3.75	960	2.40	210	2.40	210	1.80	26	5.90	1690	2.15	113	1.95	51	1.70	16	5.50	1570
11	2.25	150	2.20	130	2.50	260	3.30	735	2.35	190	2.25	150	1.75	21	3.60	885	2.00	62	1.90	41	1.80	26	5.10	1442
12	2.40	210	2.15	113	2.60	310	3.00	560	2.30	170	2.20	130	1.75	21	2.95	525	1.75	21	1.90	41	1.80	26	3.55	860
13	2.35	190	2.15	113	2.50	260	2.45	235	2.30	170	2.20	130	1.70	16	2.70	365	1.80	26	1.85	33	1.80	26	3.10	625
14	2.30	170	2.15	113	2.50	260	2.10	95	2.25	150	2.20	130	1.70	16	2.45	235	1.80	26	1.85	33	1.80	26	3.00	560
15	2.35	190	2.10	95	2.50	260	3.60	885	2.25	150	2.15	113	1.75	21	2.35	190	2.00	62	1.80	26	1.80	26	2.90	495
16	2.45	235	2.10	95	2.45	235	2.90	495	2.20	130	2.10	95	1.75	21	2.25	150	1.85	33	1.80	26	1.90	41	2.85	460
17	2.55	285	2.10	95	2.45	235	2.75	395	2.20	130	2.05	78	1.70	16	2.25	150	1.75	21	1.80	26	2.00	62	3.55	860
18	2.90	495	2.05	78	2.40	210	2.65	337	2.20	130	2.00	62	1.90	41	2.40	210	1.70	16	1.80	26	3.00	560	3.20	680
19	3.05	595	2.05	78	2.40	210	2.60	310	2.15	113	2.00	62	2.00	62	3.45	810	1.70	16	1.80	26	3.40	785	2.80	425
20	2.75	395	2.05	78	2.35	190	2.50	260	2.10	95	2.00	62	1.85	33	3.30	735	1.65	12	1.95	51	2.95	525	2.80	425
21	2.90	495	2.30	170	2.35	190	2.60	310	2.05	78	2.10	95	1.70	16	3.25	705	1.80	26	2.10	95	2.75	395	2.70	365
22	2.90	495	2.75	395	2.40	210	2.65	337	2.00	62	2.10	95	1.90	41	2.95	525	1.75	21	1.90	41	2.60	310	2.60	310
23	7.00	2020	2.60	310	2.35	190	2.80	425	2.00	62	2.30	170	2.70	365	2.75	395	1.75	21	1.85	33	2.35	190	2.55	285
24	3.75	960	2.50	260	2.30	170	2.75	395	1.95	51	2.25	150	2.35	190	2.60	310	1.70	16	1.85	33	2.30	170	2.50	260
25	3.15	650	2.45	235	2.30	170	2.70	365	1.95	51	2.10	95	2.10	95	2.50	260	1.75	21	1.80	26	2.30	170	2.45	235
26	2.85	460	2.40	210	2.45	235	2.70	365	1.95	51	2.00	62	2.00	62	2.40	210	1.75	21	1.75	21	2.25	150	2.45	235
27	2.70	365	2.35	190	3.60	885	2.60	310	2.05	78	2.05	78	1.95	51	2.30	170	1.75	21	1.75	21	2.20	130	2.55	285
28	2.60	310	2.30	170	5.00	1410	2.50	260	2.70	365	2.00	62	1.90	41	2.25	150	1.80	26	1.85	33	2.20	130	3.10	625
29	2.50	260	....	...	3.80	985	2.40	210	2.35	190	2.00	62	1.90	41	2.20	130	1.75	21	1.85	33	2.15	113	3.05	595
30	2.45	235	....	...	4.70	1375	2.40	210	2.25	150	1.95	51	2.00	62	2.15	113	1.80	26	1.85	33	2.10	95	3.45	810
31	2.40	210	....	...	5.40	1540	....	...	2.15	113	....	..	1.90	41	2.10	95	....	..	1.80	26	....	...	5.60	1600

Note. Discharge probably unaffected by ice conditions during 1906.

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1907.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec. ft.*
1	4.80	1342	2.35	190	2.70	365	2.40	210	2.70	365	3.25	705
2	3.55	860	2.55	285	3.20	680	2.40	210	2.60	310	4.00	1075
3	3.20	680	3.35	760	3.00	560	2.30	170	2.65	337	3.25	705
4	3.20	680	2.50	260	2.75	395	2.25	150	2.80	425	2.60	310
5	3.00	560	2.25	150	2.50	260	2.20	130	2.50	260	3.00	560
6	2.80	425	2.25	150	2.35	190	2.20	130	2.50	260	2.50	260
7	2.80	425	2.20	130	2.25	150	2.25	150	2.85	460	2.50	260
8	3.30	735	2.25	150	2.20	130	2.35	190	2.90	495	2.70	365
9	3.90	1030	2.30	170	2.30	170	2.40	210	5.00	1410	2.55	285
10	3.20	680	2.40	210	2.35	190	2.60	310	3.40	785	2.35	190
11	3.00	560	2.35	190	2.65	337	2.70	365	3.10	625	4.40	1255
12	9.00	2620	2.30	170	2.70	365	2.90	495	2.85	460	3.80	985
13	4.00	1075	2.25	150	14.40	4240	2.70	365	2.75	395	3.80	985
14	8.80	2560	2.35	190	17.00	5020	2.70	365	2.65	337	4.80	1415
15	5.75	1644	2.50	260	6.70	1930	2.60	310	2.45	235	3.85	1010
16	3.95	1050	2.50	260	5.20	1476	3.00	560	2.50	260	3.10	625
17	3.80	985	2.45	235	4.25	1185	3.05	595	2.50	260	2.80	425
18	4.90	1376	2.40	210	3.85	1010	2.90	495	2.50	260	2.65	337
19	9.60	2860	2.60	310	12.35	3725	2.90	495	2.65	337	2.55	285
20	6.30	1810	2.95	525	7.70	2230	2.85	460	3.15	650	2.45	235
21	3.80	985	2.80	425	4.25	1185	2.80	425	2.70	365	2.35	190
22	3.30	735	2.70	365	3.45	810	2.75	395	2.65	337	2.30	170
23	2.90	495	2.60	310	3.20	680	2.80	425	2.60	310	2.30	170
24	2.80	425	2.50	260	2.95	525	3.90	1039	2.55	285	2.30	170
25	3.00	560	2.50	260	2.70	365	3.40	785	2.50	260	2.30	170
26	2.80	425	2.50	260	2.65	337	3.05	595	2.70	365	2.25	150
27	2.60	310	2.50	260	2.65	337	2.95	525	3.45	810	2.20	130
28	2.50	260	2.50	260	2.70	365	2.90	495	3.30	735	2.10	95
29	2.45	235	....	...	2.60	310	2.80	425	3.20	680	2.15	113
30	2.40	210	....	...	2.50	260	2.75	395	3.00	560	2.20	130
31	2.40	210	....	...	2.45	235	....	...	3.00	560	....	..

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.20	130	2.30	170	2.00	62	2.05	78	2.10	95	2.50	260
2	2.50	260	2.20	130	2.00	62	1.95	51	2.05	78	2.45	235
3	2.25	150	2.10	95	2.30	170	1.90	41	4.25	1185	2.30	170
4	2.15	113	2.05	78	2.40	210	2.05	78	4.30	1210	2.20	130
5	2.10	95	2.00	62	2.25	150	2.00	62	3.50	835	2.25	150
6	2.10	95	2.55	285	2.20	130	2.15	113	3.05	595	2.15	113
7	2.05	78	2.25	150	2.15	113	2.05	78	4.00	1075	2.05	78
8	2.05	78	2.40	210	2.10	95	2.00	62	5.10	1443	2.35	190
9	2.00	62	2.35	190	2.10	95	2.60	310	3.10	625	2.50	260
10	1.95	51	2.30	170	2.05	78	2.35	190	3.00	560	4.75	1395
11	2.60	310	2.25	150	2.60	310	2.20	130	2.80	425	4.70	1375
12	3.85	1010	2.35	190	2.55	285	2.10	95	2.65	337	4.50	1295
13	3.00	560	2.20	130	2.25	150	2.20	130	2.55	285	4.15	1145
14	2.60	310	2.10	95	2.20	130	2.25	150	2.50	260	3.95	1050
15	2.40	210	2.05	78	2.15	113	2.15	113	2.45	235	3.70	935
16	2.35	190	2.05	78	2.10	95	2.10	95	2.35	190	2.95	525
17	4.05	1095	2.00	62	2.05	78	2.05	78	2.30	170	2.70	365
18	4.20	1165	1.95	51	2.10	95	2.10	95	2.40	210	2.50	260
19	3.40	785	1.90	41	2.20	130	2.05	78	2.50	260	2.30	170
20	2.90	495	1.90	41	2.15	113	2.05	78	2.45	235	2.20	130
21	2.70	365	1.90	41	2.05	78	2.00	62	2.40	210	2.25	150
22	2.50	260	1.85	33	2.20	130	2.00	62	2.50	260	2.40	210
23	2.40	210	2.15	113	2.10	95	2.00	62	2.45	235	4.85	1435
24	2.40	210	3.60	885	2.10	95	1.95	51	2.45	235	4.75	1395
25	2.30	170	2.90	495	2.00	62	1.90	41	2.50	260	3.80	985
26	3.20	680	2.70	365	2.00	62	1.90	41	2.50	260	3.10	625
27	2.80	425	2.50	260	1.90	41	1.95	51	2.55	285	2.95	525
28	2.45	235	2.30	170	1.80	26	2.85	460	2.75	395	3.35	760
29	2.30	170	2.20	130	1.75	21	2.45	235	2.65	337	3.45	810
30	2.25	150	2.10	95	2.10	95	2.20	130	2.55	285	3.25	705
31	2.20	130	2.00	62	....	..	2.25	150	....	...	3.00	560

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1908.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.85	460	2.65	337	2.55	285	3.25	705	2.80	425	2.50	260	1.85	33	1.75	21	1.50	4	1.60	8	1.45	2	1.50	4
2	2.75	395	2.55	285	5.10	1443	3.45	810	2.70	365	2.40	210	1.85	33	1.70	16	1.50	4	1.60	8	1.45	2	1.50	4
3	2.60	310	2.50	260	4.35	1235	3.20	680	2.65	337	2.30	170	1.85	33	1.65	12	1.45	2	1.60	8	1.45	2	1.50	4
4	2.55	285	2.45	235	3.60	885	3.00	560	2.95	525	2.25	150	1.80	26	1.60	8	1.45	2	1.60	8	1.45	2	1.50	4
5	2.50	260	2.40	210	3.50	835	2.85	460	4.10	1120	2.20	130	1.80	26	1.60	8	1.40	1	1.60	8	1.45	2	1.50	4
6	2.45	235	2.45	235	5.10	1443	2.85	460	3.70	935	2.20	130	1.80	26	1.60	8	1.40	1	1.55	6	1.45	2	1.50	4
7	2.45	235	2.50	260	8.15	2365	2.75	395	7.65	2215	2.15	113	1.80	26	1.75	21	1.40	1	1.55	6	1.45	2	1.60	8
8	2.45	235	2.35	190	3.85	1010	4.15	1145	4.75	1395	2.10	95	1.80	26	1.70	16	1.40	1	1.50	4	1.45	2	1.65	12
9	2.40	210	2.35	190	5.50	1570	3.95	1050	4.60	1335	2.10	95	1.80	26	1.70	16	1.40	1	1.45	2	1.45	2	1.55	6
10	2.40	210	2.40	210	3.85	1010	3.35	760	3.20	680	2.05	78	1.75	21	1.65	12	1.35	0	1.40	1	1.45	2	1.60	8
11	2.35	190	2.35	190	3.40	785	5.50	1570	2.60	310	2.00	62	1.75	21	1.60	8	1.35	0	1.40	1	1.50	4	1.65	12
12	4.50	1295	2.70	365	3.60	885	3.65	910	2.60	310	2.00	62	1.75	21	1.60	8	1.35	0	1.40	1	1.50	4	1.75	21
13	3.45	810	3.30	735	3.85	1010	3.20	680	2.65	337	1.95	51	1.75	21	1.60	8	1.35	0	1.40	1	1.50	4	1.75	21
14	3.15	650	3.80	985	4.40	1255	2.90	495	2.55	285	1.90	41	1.75	21	1.55	6	1.35	0	1.40	1	1.50	4	1.85	33
15	2.80	425	12.20	3580	4.35	1235	2.95	525	2.80	425	2.15	113	1.90	41	1.55	6	1.35	0	1.40	1	1.50	4	1.85	33
16	2.65	337	5.50	1570	4.05	1095	2.90	495	2.60	310	2.10	95	1.85	33	1.55	6	1.35	0	1.40	1	1.50	4	1.90	41
17	2.50	260	3.70	935	3.55	860	2.85	460	2.65	337	2.05	78	1.80	26	1.55	6	1.35	0	1.40	1	1.50	4	2.10	95
18	2.45	235	3.45	810	6.15	1765	2.80	425	2.80	425	2.00	62	1.75	21	2.00	62	1.30	0	1.40	1	1.55	6	3.10	625
19	2.40	210	3.10	625	9.05	2635	3.50	835	3.30	735	1.95	51	1.75	21	2.00	62	1.30	0	1.40	1	1.55	6	2.70	365
20	2.35	190	2.90	495	4.50	1295	3.10	625	3.60	885	1.90	41	1.75	21	1.90	41	1.30	0	1.40	1	1.60	8	2.20	130
21	2.50	260	2.80	425	3.50	835	3.00	560	3.35	760	2.10	95	1.70	16	1.85	33	1.30	0	1.40	1	1.60	8	2.05	78
22	2.95	525	2.60	310	3.20	680	2.90	495	3.70	935	2.05	78	2.40	210	1.80	26	1.30	0	1.40	1	1.60	8	2.00	62
23	2.90	495	2.60	310	3.00	560	2.80	425	3.00	560	2.00	62	2.10	95	1.80	26	1.30	0	1.40	1	1.55	6	1.95	51
24	2.60	310	2.55	285	3.00	560	2.70	365	2.75	395	2.40	210	3.10	625	1.80	26	1.30	0	1.40	1	1.55	6	1.95	51
25	2.55	285	2.50	260	2.85	460	2.60	310	2.60	310	2.30	170	3.05	595	1.75	21	1.30	0	1.45	2	1.55	6	1.90	41
26	2.55	285	2.45	235	2.85	460	2.50	260	2.55	285	2.10	95	2.80	425	1.70	16	1.30	0	1.45	2	1.55	6	1.90	41
27	3.15	650	2.40	210	2.75	395	2.45	235	2.50	260	2.00	62	2.60	310	1.70	16	1.30	0	1.45	2	1.55	6	1.90	41
28	3.00	560	2.40	210	2.75	395	2.40	210	2.40	210	1.90	41	2.40	210	1.65	12	1.50	4	1.45	2	1.55	6	2.00	62
29	2.60	310	2.35	190	3.90	1030	2.40	210	2.40	210	1.90	41	2.20	130	1.60	8	1.50	4	1.45	2	1.55	6	1.95	51
30	2.35	190	....	...	3.30	735	2.45	235	2.80	425	1.85	33	2.00	62	1.55	6	1.60	8	1.45	2	1.50	4	1.85	33
31	2.55	285	....	...	3.60	885	....	...	2.60	310	....	..	1.85	33	1.50	4	....	...	1.45	2	....	..	1.95	51

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec. ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.95	51	2.30	170	2.90	495	2.70	365	3.30	735	2.20	130	2.10	95	1.65	12	1.85	33	1.55	6	1.90	41	1.80	26
2	1.95	51	2.40	210	3.60	885	2.70	365	3.10	625	2.25	150	2.05	78	1.60	8	1.80	26	1.55	6	1.85	33	1.80	26
3	2.10	95	2.30	170	4.40	1255	2.75	395	3.00	560	2.10	95	2.00	62	1.60	8	1.75	21	1.50	4	1.85	33	1.80	26
4	2.10	95	2.50	260	4.00	1075	2.95	525	3.10	625	2.20	130	1.95	51	1.60	8	1.75	21	1.50	4	1.85	33	1.75	21
5	2.00	62	2.80	425	3.65	910	2.90	495	2.90	495	2.75	395	1.90	41	1.60	8	2.00	62	1.50	4	1.80	26	1.75	21
6	2.50	260	3.10	625	3.30	735	2.80	425	2.70	365	3.40	785	1.85	33	1.60	8	1.80	26	1.50	4	1.80	26	1.75	21
7	2.30	170	2.80	425	3.50	835	2.90	495	2.60	310	2.80	425	1.85	33	1.60	8	1.70	16	1.50	4	1.80	26	1.90	41
8	2.10	95	2.65	337	3.80	985	2.80	425	2.50	260	2.70	365	1.80	26	1.60	8	1.70	16	1.50	4	1.80	26	2.25	150
9	2.30	170	2.40	210	3.70	935	2.70	365	2.50	260	2.60	310	1.80	26	1.60	8	1.70	16	1.50	4	1.85	33	2.20	130
10	2.20	130	2.60	310	3.75	960	2.60	310	2.50	260	5.85	1675	1.70	16	1.55	6	1.70	16	1.50	4	1.85	33	2.10	95
11	2.20	130	3.80	985	3.15	650	2.55	285	2.50	260	4.00	1075	1.70	16	1.55	6	1.70	16	1.75	21	1.85	33	2.05	78
12	2.20	130	3.65	910	2.90	495	2.55	285	2.40	210	3.40	785	1.70	16	1.55	6	1.75	21	2.15	113	1.85	33	2.05	78
13	2.15	113	3.55	860	2.80	425	2.65	337	2.35	190	2.90	495	1.70	16	1.55	6	1.75	21	1.90	41	1.80	26	2.80	425
14	2.10	95	3.15	650	2.70	365	4.30	1210	2.30	170	2.90	495	1.65	12	1.55	6	1.70	16	1.80	26	1.90	41	4.00	1075
15	3.50	835	3.15	650	2.55	285	3.50	835	2.25	150	2.75	395	1.65	12	1.75	21	1.70	16	1.80	26	1.90	41	2.80	425
16	3.05	595	4.50	1295	2.50	260	3.10	625	2.20	130	2.60	310	1.65	12	3.70	935	1.70	16	1.80	26	1.85	33	2.60	310
17	2.65	337	3.50	835	2.40	210	2.85	460	2.15	113	2.50	260	1.65	12	2.90	495	1.65	12	1.75	21	1.85	33	2.40	210
18	2.55	285	3.05	595	2.40	210	2.70	365	2.05	78	2.40	210	1.65	12	2.70	365	1.65	12	1.70	16	1.85	33	2.30	170
19	2.25	150	2.95	525	2.50	260	2.70	365	2.05	78	2.40	210	1.65	12	2.45	235	1.60	8	1.85	33	1.80	26	2.20	130
20	2.50	260	3.05	595	2.85	460	3.70	935	2.05	78	2.35	190	1.65	12	2.35	190	1.60	8	1.85	33	1.80	26	2.10	95
21	2.45	235	2.85	460	2.65	337	4.10	1120	2.15	113	2.35	190	1.60	8	2.50	260	1.60	8	1.85	33	1.80	26	2.00	62
22	2.60	310	2.75	395	2.60	310	4.85	1359	2.15	113	2.35	190	1.60	8	2.25	150	1.60	8	1.90	41	1.80	26	1.95	51
23	3.45	810	3.30	735	2.50	260	4.05	1095	2.10	95	2.30	170	1.60	8	2.15	113	1.60	8	2.25	150	1.80	26	1.90	41
24	3.80	985	6.10	1750	2.50	260	3.55	860	2.05	78	2.30	170	1.75	21	2.10	95	1.75	21	2.25	150	1.80	26	1.90	41
25	3.20	680	4.10	1120	2.70	365	3.10	625	2.00	62	2.30	170	1.75	21	2.00	62	1.75	21	2.40	210	1.85	33	2.10	95
26	2.80	425	3.35	760	2.75	395	3.05	595	1.95	51	2.25	150	1.70	16	1.90	41	1.75	21	2.10	95	1.85	33	2.20	130
27	2.65	337	3.30	735	2.90	495	2.80	425	2.30	170	2.35	190	1.70	16	1.90	41	1.70	16	2.10	95	1.85	33	2.20	130
28	2.60	310	3.20	680	3.00	560	2.70	365	2.45	235	2.30	170	1.70	16	1.85	33	1.65	12	2.00	62	1.85	33	2.20	130
29	2.50	260	....	...	2.95	525	2.75	395	2.20	130	2.25	150	1.65	12	1.95	51	1.65	12	2.00	62	1.80	26	2.20	130
30	2.30	170	....	...	2.90	495	3.10	625	2.05	78	2.15	113	1.65	12	1.95	51	1.60	8	1.95	51	1.80	26	2.20	130
31	2.20	130	....	...	2.80	425	....	...	2.10	95	....	...	1.65	12	1.90	41	...	..	1.90	41	....	..	2.20	130

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Feet Ht.	Sec.-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.40	232	2.50	284	5.38	1534	2.03	85	2.43	248	2.88	501	2.13	117	1.48	10	1.68	22	1.33	5	1.43	8	1.58	15
2	4.15	1118	2.45	258	4.78	1335	1.98	71	2.38	223	3.48	830	2.08	100	1.48	10	1.68	22	1.33	5	1.43	8	1.58	15
3	8.00	2320	2.65	361	4.33	1182	1.93	59	2.33	199	3.18	679	2.03	85	1.43	8	1.68	22	1.33	5	1.43	8	1.58	15
4	4.30	1171	2.55	311	4.03	1072	1.88	49	2.28	176	2.88	501	1.98	71	1.43	8	1.98	71	1.33	5	1.38	6	1.58	15
5	3.35	766	2.45	258	4.03	1072	2.03	85	2.23	155	3.13	652	1.93	59	1.43	8	1.98	71	1.33	5	1.38	6	1.58	15
6	4.30	1171	2.35	208	4.08	1092	1.98	71	2.23	155	3.53	853	1.93	59	1.38	6	1.83	40	1.33	5	1.33	5	1.68	22
7	4.40	1206	2.30	185	3.58	876	1.93	59	2.18	135	3.08	625	1.88	49	1.38	6	1.78	33	1.33	5	1.33	5	1.68	22
8	3.50	840	2.30	185	3.33	756	1.88	49	2.18	135	2.83	473	1.88	49	1.38	6	1.83	40	1.43	8	1.33	5	1.68	22
9	3.15	663	2.45	258	3.08	625	1.93	59	2.33	199	2.83	473	1.98	71	1.38	6	1.68	22	1.43	8	1.33	5	1.68	22
10	2.85	484	3.00	581	2.83	473	1.93	59	2.43	248	3.38	780	1.98	71	1.38	6	1.63	18	1.38	6	1.33	5	d	..
11	2.65	366	2.80	456	2.68	384	1.93	59	2.98	569	3.58	876	1.93	59	1.38	6	1.58	15	1.38	6	1.33	5	d	..
12	2.55	311	2.60	338	2.63	355	1.88	49	2.98	569	3.18	679	1.88	49	1.38	6	1.58	15	1.38	6	1.33	5	d	..
13	2.45	258	2.50	284	2.63	355	1.88	49	2.88	501	2.88	501	1.88	49	1.38	6	1.53	13	1.38	6	1.33	5	d	..
14	2.40	232	2.45	258	2.58	327	1.83	40	2.98	569	2.68	384	1.88	49	1.38	6	1.53	13	1.38	6	1.33	5	d	..
15	2.35	208	2.45	258	2.53	300	1.83	40	2.78	444	2.53	300	1.83	40	1.43	8	1.53	13	1.33	5	1.33	5	d	..
16	2.35	208	3.80	975	2.48	274	1.83	40	2.63	355	2.38	223	1.83	40	1.43	8	1.48	10	1.33	5	1.33	5	d	..
17	2.30	185	3.80	975	2.38	223	1.83	40	2.48	274	2.58	327	2.23	155	1.38	6	1.48	10	1.33	5	1.33	5	d	..
18	a8.05	2335	3.40	232	2.28	176	1.78	33	2.38	223	2.38	223	2.08	100	1.38	6	1.48	10	1.33	5	1.33	5	d	..
19	5.20	1476	3.15	663	2.23	155	1.78	33	2.48	274	c9.73	1700	1.98	71	1.53	13	1.48	10	1.33	5	1.48	10	d	..
20	3.55	862	2.90	522	2.53	300	1.78	33	2.48	274	3.88	1011	1.88	49	1.48	10	1.43	8	1.33	5	1.48	10	d	..
21	4.70	1308	3.20	690	2.43	248	1.88	49	2.43	248	3.08	625	1.83	40	1.48	10	1.43	8	1.33	5	1.48	10	d	..
22	3.85	997	4.55	1257	2.38	223	2.58	327	2.38	223	2.78	444	1.78	33	1.48	10	1.43	8	1.33	5	1.48	10	d	..
23	3.35	766	3.45	815	2.33	199	2.88	501	2.38	223	2.58	327	1.78	33	1.48	10	1.43	8	1.43	8	1.48	10	1.78	33
24	3.00	581	b3.08	625	2.33	199	2.78	444	2.38	223	2.43	248	1.73	25	1.43	8	1.43	8	1.43	8	1.48	10	1.78	33
25	2.85	484	2.83	473	2.28	176	3.98	1052	2.38	223	2.28	176	1.68	22	1.43	8	1.38	6	1.43	8	1.58	15	1.78	33
26	2.75	425	2.78	444	2.28	176	3.43	805	2.33	199	2.28	176	1.58	15	1.43	8	1.38	6	1.43	8	1.58	15	1.78	33
27	3.05	603	2.98	569	2.33	199	3.03	599	2.23	155	2.23	155	1.53	13	1.43	8	1.38	6	1.43	8	1.58	15	1.78	33
28	2.80	456	4.48	1233	2.28	176	2.88	501	2.23	155	2.43	248	1.48	10	1.38	6	1.38	6	1.43	8	1.58	15	1.78	33
29	2.70	395	....	....	2.18	135	2.68	384	2.23	155	2.28	176	1.48	10	1.38	6	1.38	6	1.43	8	1.58	15	1.88	49
30	2.60	338	....	....	2.13	117	2.58	327	2.23	155	2.18	135	1.58	15	1.38	6	1.33	5	1.43	8	1.58	15	4.28	1199
31	2.50	284	....	....	2.08	100	...	...	2.48	274	....	...	1.48	10	1.38	6	....	..	1.43	8	....	..	3.28	732

a. Max. 8.40 = 2440 sec.-ft. b. Weight lost and replaced. For balance of year gage heights may be slightly in error. c. Backwater from Youghiogheny; 60 per cent of apparent discharge used. d. Frozen.

Daily Gage Heights and Discharges of Laurel Hill Creek at Confluence, Pa., for 1911.

Day	January		February		March		April		May	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.98	569	3.28	732	2.98	569	2.63	355	2.58	327
2	3.18	679	2.93	540	2.93	540	2.58	327	2.88	501
3	4.18	1129	2.58	327	2.88	501	2.53	300	2.78	444
4	3.28	732	2.58	327	2.78	444	2.93	540	2.68	384
5	2.88	501	2.58	327	2.73	413	4.78	1335	2.58	327
6	2.63	355	2.53	300	2.73	413	6.48	1864	2.48	274
7	2.48	274	2.53	300	2.73	413	3.63	899	2.38	223
8	2.38	223	2.48	274	2.73	413	3.68	921	2.28	174
9	2.33	199	2.48	274	2.68	384	3.28	732	2.18	135
10	2.28	176	2.43	248	2.68	384	3.28	732	2.13	117
11	2.58	327	2.38	223	2.68	384	3.18	679	2.08	100
12	3.48	830	2.33	199	2.63	355	2.93	540	2.03	85
13	9.48	3640	2.38	233	2.63	355	2.88	501	2.03	85
14	5.88	1684	2.93	540	2.68	384	2.88	501	2.03	85
15	4.48	1233	3.38	780	2.78	444	3.08	625	2.03	85
16	3.63	898	3.08	625	2.68	384	2.83	473	2.03	85
17	3.13	652	2.88	501	2.68	384	2.73	413	2.03	85
18	2.98	569	2.78	444	2.68	384	2.68	384	1.98	71
19	2.88	501	2.68	384	2.88	501	2.73	413	1.98	71
20	2.68	384	2.63	355	3.28	732	3.18	679	1.98	71
21	2.68	384	2.58	327	3.18	679	3.03	599	1.93	59
22	2.58	327	2.53	300	3.08	625	3.08	625	1.93	59
23	2.48	274	2.53	300	2.98	569	3.13	652	1.88	49
24	2.43	248	2.53	300	2.93	540	2.93	540	2.28	174
25	2.33	199	2.58	327	2.88	501	2.83	473	2.18	135
26	2.73	413	2.68	384	2.83	473	2.73	413	2.08	100
27	2.98	569	3.08	625	2.78	444	2.63	355	1.98	71
28	3.03	599	3.08	625	2.78	444	2.53	300	1.88	49
29	3.43	805	....	....	2.73	413	2.48	274	1.88	49
30	8.88	2345	....	....	2.68	384	2.43	248	2.28	174
31	4.88	1369	....	....	2.63	355	....	....	2.08	100

Estimated Monthly Discharge of Laurel Hill Creek at Confluence, Pa.

[Drainage area, 126 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
October	26	8	13	0.103	0.119
November	16	8	13	0.103	0.115
December	885	16	158	1.254	1.446
1905					
January 1–26	935	62	245	1.944	1.931
March 8–31	2309	260	982	7.792	6.830
April	650	170	297	2.357	2.630
May	560	78	202	1.603	1.848
June	1335	41	390	3.095	3.454
July	705	41	153	1.214	1.400
August	1210	33	264	2.095	2.416
September	1145	26	195	1.548	1.727
October	1120	12	171	1.357	1.564
November	1397	62	214	1.698	1.895
December	1980	113	452	3.587	4.135

Estimated Monthly Discharge of Laurel Hill Creek at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1906					
January	2020	150	436	3.456	3.984
February	395	78	159	1.262	1.298
March	1540	170	399	3.166	3.639
April	1335	95	541	4.294	4.791
May	365	51	152	1.206	1.390
June	835	26	159	1.262	1.408
July	365	16	52	0.413	0.476
August	1690	33	409	3.918	4.517
September	113	12	37	0.294	0.328
October	170	21	48	0.381	0.439
November	785	16	140	1.111	1.239
December	1600	170	574	4.565	5.263
The year	2020	12	259	2.111	28.772
1907					
January	2860	210	929	7.374	8.501
February	525	130	263	2.088	2.174
March	5020	130	968	7.682	8.856
April	1030	130	395	3.135	3.498
May	1410	235	458	3.635	4.191
June	1415	95	459	3.643	4.064
July	1165	51	331	2.627	3.029
August	885	33	165	1.309	1.509
September	285	21	112	0.889	0.992
October	460	41	111	0.881	1.016
November	1443	78	436	3.460	3.860
December	1435	78	593	4.706	5.426
The year	5020	21	435	3.457	47.116
1908					
January	1295	190	374	2.968	3.422
February	3580	190	522	4.143	4.468
March	2635	285	1029	8.167	9.416
April	1570	210	588	4.667	5.207
May	2215	210	575	4.532	5.225
June	260	33	99	0.786	0.877
July	625	16	104	0.825	0.951
August	62	4	18	0.143	0.165
September	8	0	1	0.008	0.009
October	8	1	3	0.024	0.028
November	8	2	4	0.032	0.035
December	625	4	64	0.508	0.586
The year	3580	0	265	2.233	30.389
1909					
January	985	51	283	2.246	2.589
February	1750	170	631	5.008	5.215
March	1255	210	552	4.381	5.051
April	1359	285	578	4.587	5.118
May	735	51	231	1.833	2.113
June	1675	95	311	2.437	2.719
July	95	8	24	0.190	0.219
August	935	6	106	0.841	0.969
September	62	8	18	0.143	0.159
October	210	4	45	0.357	0.412
November	41	26	31	0.246	0.275
December	1075	21	149	1.183	1.364
The year	1750	4	247	1.954	26.203

Estimated Monthly Discharge of Laurel Hill Creek at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	2440	185	743	5.900	6.802
February	1233	185	498	3.956	4.120
March	1534	100	435	3.452	3.979
April	1052	33	202	1.603	1.788
May	569	135	262	2.080	2.309
June	1700	135	510	4.048	4.516
July	155	10	52	0.413	0.476
August	10	6	8	0.060	0.069
September	71	5	18	0.144	0.161
October	8	5	6	0.049	0.056
November	15	5	8	0.066	0.074
1911					
January	3640	176	745	5.912	6.816
February	780	199	397	3.151	3.281
March	732	355	457	3.627	4.181
April	1864	248	590	4.682	5.223
May	501	49	153	1.215	1.401

Note. Discharges should be used with caution on account of the station being affected by backwater.

CASSELMAN RIVER AT CONFLUENCE, PA.

This station, situated on a two-span steel highway bridge, about 500 yards from the railroad station at Confluence, Somerset Co., Pa., was established September 15, 1904, by E. C. Murphy, for the U. S. Geological Survey. In 1907 the station was taken over by the Water Supply Commission of Pennsylvania, and has since been maintained by that commission.

A standard chain gage 21.40 feet from marker to bottom of weight is fastened to the upstream handrail of the bridge.

Discharge measurements are made from the upstream side of the bridge. The initial point for soundings is the center of the bridge pin over the right abutment on the upstream side.

Bench Mark No. 1 is a chisel mark, painted, on the right abutment on downstream side, and has an elevation of 18.61 feet above the zero of the gage. Bench Mark No. 2 is a cross on top of lower chord of the bridge near the gage, and has an elevation of 18.61 feet above the zero of the gage.

The channel is straight for 200 feet above and 500 feet below the station. The bed of the stream is covered with boulders and, in places, with water-weeds. The current is swift. The right bank is high and does not overflow. The left bank is low and overflows in extreme high water. There is an extreme range of about 17 feet between high and low water.

The station is located only a few hundred yards above the junction of the Casselman and Youghiogheny Rivers, and as a result, backwater occurs at high stages, probably above a gage height of 4.0 feet. Above 4.0 feet, a double reversed curve has been used, showing about from 1 to 2 feet of backwater. The backwater effect varies with each flood, and the higher discharges herein given should be used with caution.

The gage is read daily by L. L. Mountain.

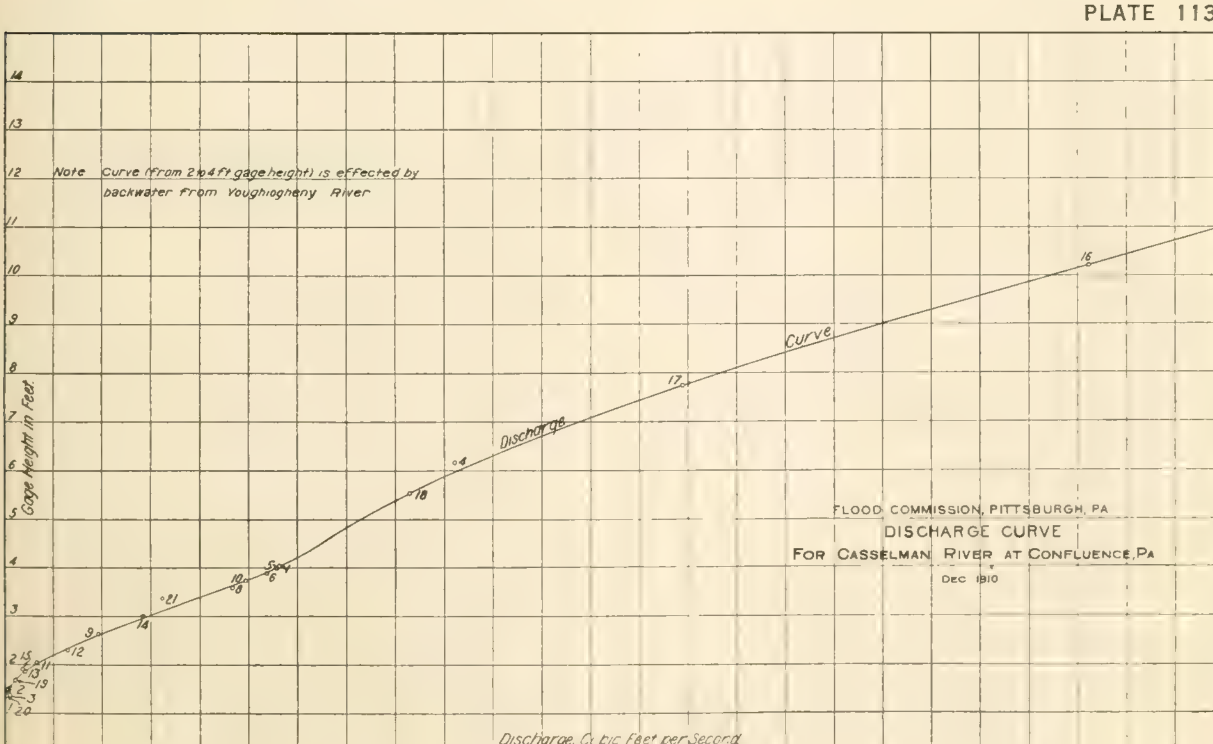
The drainage area above the station is 448 square miles.

Discharge Measurements of Casselman River at Confluence, Pa.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1904							
July	8	Hoyt and Hall	224	293	1.30	2.32	381
Sept.	12	E. C. Murphy	230	279	0.80	1.65	224
Sept.	27	N. C. Grover	194	123	0.36	1.50	44
1905							
Mar.	11	E. C. Murphy	220	107	0.27	1.49	29
Mar.	15	N. C. Grover	248	1186	3.11	a6.16	3688
Mar.	15	do	247	609	3.70	4.02	2253
Mar.	16	do	230	576	3.74	3.89	2155
Mar.	28	E. C. Murphy	231	605	3.68	3.99	2230
April	17	A. H. Horton	229	516	3.63	3.59	1870
April	22	do	214	344	2.25	2.63	772
June	6	R. H. Bolster	228	559	3.54	3.73	1980
Nov.	4	Hanna and Grieve	205	214	1.29	2.02	277
1906							
May	25	U. S. Geological Survey	233	330	1.59	2.30	526
1907							
June	10	A. H. Horton	212	166	1.05	1.87	175
Aug.	15	H. D. Padgett	217	409	2.79	3.00	1140
1908							
Feb.	16	F. F. Henshaw	194	172	0.89	1.88	153
Feb.	16	do	248	2170	4.09	10.20	8900
Feb.	17	do	248	1560	3.56	7.73	5560
Aug.	21	R. H. Bolster	228	1010	3.29	5.52	3320
Sept.	25b	F. E. Langenheim	69	68	0.19	1.35	13
1909							
June	12	F. W. Scheidenhelm	219	148	0.57	1.67	85
1911							
July	13	F. E. Langenheim	232	508	2.54	3.39	1292

a. Backwater. b. Wading measurement.

PLATE 113



Rating Table for Casselman River at Confluence, Pa.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.30	9	2.90	1070	4.50	2600	6.10	3815	7.70	5525
.40	19	3.00	1175	.60	2660	.20	3910	.80	5640
.50	36	.10	1281	.70	2720	.30	4010	.90	5760
.60	61	.20	1388	.80	2785	.40	4110	8.00	5880
.70	95	.30	1497	.90	2850	.50	4210	9.00	7200
.80	141	.40	1608	5.00	2920	.60	4310	10.00	8600
.90	196	.50	1720	.10	2990	.70	4410	11.00	10000
2.00	260	.60	1835	.20	3065	.80	4510	12.00	11400
.10	331	.70	1945	.30	3140	.90	4610	13.00	12800
.20	408	.80	2050	.40	3220	7.00	4720	14.00	14200
.30	491	.90	2145	.50	3300	.10	4835	15.00	15600
.40	579	4.00	2235	.60	3380	.20	4950	16.00	17000
.50	671	.10	2315	.70	3460	.30	5065	.....	.....
.60	767	.20	2390	.80	3545	.40	5180	.....	.....
.70	866	.30	2465	.90	3630	.50	5295	.....	.....
.80	967	.40	2535	6.00	3720	.60	5410	.....	.....

Note: This table should be used with caution on account of station being affected by backwater.
Discharges approximate above gage height 7 feet.

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1904.

Day	September		October		November		December		Day	September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge		Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	..	1.40	20	1.45	28	1.55	49	17	1.55	49	1.50	37	1.45	28	b1.60	61
2	....	..	1.40	20	1.45	28	1.55	49	18	1.50	37	1.50	37	1.45	28	a	....
3	....	..	1.40	20	1.45	28	1.55	49	19	1.45	28	1.45	28	1.45	28	a	....
4	....	..	1.35	14	1.45	28	1.55	49	20	1.45	28	1.40	20	1.50	37	a	....
5	....	..	1.35	14	1.40	20	1.55	49	21	1.55	49	1.50	37	1.50	37	a	....
6	....	..	1.35	14	1.40	20	1.55	49	22	1.50	37	1.50	37	1.50	37	a	....
7	....	..	1.35	14	1.40	20	1.55	49	23	1.45	28	1.50	37	1.50	37	a	....
8	....	..	1.40	20	1.40	20	1.55	49	24	1.45	28	1.50	37	1.55	49	b1.95	226
9	....	..	1.45	28	1.40	20	1.55	49	25	1.45	28	1.50	37	1.55	49	c3.35	1530
10	....	..	1.45	28	1.40	20	1.55	49	26	1.50	37	1.50	37	1.55	49	2.70	885
11	....	..	1.50	37	1.40	20	a	..	27	1.50	37	1.45	28	1.55	49	2.95	1090
12	....	..	1.50	37	1.40	20	a	..	28	1.45	28	1.45	28	1.55	49	4.10	2405
13	....	..	1.50	37	1.40	20	a	..	29	1.45	28	1.45	28	1.55	49	3.00	1140
14	....	..	1.60	61	1.40	20	a	..	30	1.45	28	1.45	28	1.55	49	2.05	301
15	....	..	1.60	61	1.40	20	a	..	31	....	..	1.45	28	....	..	2.15	380
16	1.55	49	1.55	49	1.40	20	a	..									

a. Frozen.
b. Hole cut in ice and gage read to water surface.
c. Ice gone out.

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1905.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.15	380	....	....	2.90	1040	2.70	855	2.40	590	2.20	420	2.40	590	2.60	765	2.20	420	1.70	93	2.50	675	3.20	1360
2	2.10	340	....	....	....	....	2.60	765	2.25	460	2.30	505	2.95	1090	2.25	460	2.10	340	1.80	132	2.40	590	3.00	1140
3	2.40	590	....	....	....	....	2.55	720	2.25	460	2.20	420	2.55	720	2.10	340	2.10	340	2.50	675	2.30	505	8.40	6490
4	2.35	545	2.60	765	2.90	1040	2.50	675	2.30	505	2.10	340	2.40	590	2.00	263	2.10	340	2.25	460	2.30	505	5.10	3115
5	2.30	505	....	....	....	....	2.50	675	2.35	545	2.05	301	2.30	505	2.30	505	2.20	420	2.00	263	2.30	505	4.35	2715
6	2.20	420	....	....	....	....	2.55	720	2.55	720	2.00	263	2.40	590	2.25	460	2.25	460	1.80	132	2.30	505	3.30	1470
7	2.15	380	....	....	3.50	1700	2.65	810	2.50	675	2.50	675	3.25	1415	2.10	340	2.35	545	1.75	112	2.30	505	3.00	1140
8	2.10	340	2.70	855	4.60	2800	2.70	855	2.45	630	2.75	900	3.60	1815	2.00	263	2.65	810	1.70	93	2.30	505	2.90	1040
9	2.10	340	....	....	6.85	4500	2.70	855	2.40	590	2.60	765	2.90	1040	1.95	226	2.85	990	1.70	93	2.25	460	2.80	945
10	2.10	340	....	....	7.30	5050	2.75	900	2.30	505	2.50	675	2.60	765	1.90	191	2.95	1090	1.65	76	2.20	420	2.70	855
11	2.15	380	2.70	855	5.60	3375	3.50	1700	2.25	460	5.70	3430	3.10	1250	3.20	1360	4.85	2960	1.95	226	2.15	380	2.60	765
12	2.35	545	....	....	4.80	2930	3.40	1585	2.55	720	4.10	2405	2.75	900	2.80	945	3.80	2045	2.80	945	2.15	380	2.50	675
13	4.70	3170	....	....	4.50	2725	3.05	1195	2.40	590	3.35	1530	2.80	945	2.40	590	2.90	1040	2.35	545	2.10	340	2.40	590
14	3.80	2045	....	....	4.25	2520	2.85	990	2.75	900	3.00	1140	2.50	675	2.30	505	2.50	675	2.15	380	2.10	340	2.30	505
15	2.95	1090	2.90	1040	4.00	2285	2.80	945	3.40	1585	2.65	810	2.30	505	5.40	3270	2.20	420	2.05	301	2.10	340	2.20	420
16	2.50	675	....	....	4.00	2285	2.70	855	3.20	1360	2.45	630	2.20	420	4.25	2590	2.20	420	2.00	263	2.20	420	2.15	380
17	2.45	630	....	....	5.50	3325	2.60	765	3.10	1250	2.40	590	2.10	340	3.20	1360	2.20	420	1.95	226	2.25	460	2.15	380
18	2.40	590	2.90	1040	6.30	3875	2.55	720	2.80	945	2.30	505	2.00	263	2.80	945	2.15	380	1.90	191	2.25	460	2.20	420
19	2.40	590	....	....	9.00	7300	2.50	675	2.65	810	2.20	420	2.00	263	2.50	675	2.10	340	2.15	380	2.15	380	2.15	380
20	2.35	545	....	....	8.50	6625	2.65	810	2.50	675	2.20	420	2.90	1040	2.35	545	2.05	301	6.10	3710	2.05	301	2.10	340
21	2.35	545	....	....	10.40	9205	2.95	1090	2.40	590	2.10	340	2.35	545	2.20	420	2.00	263	3.70	1930	2.00	263	4.00	2285
22	2.25	460	2.90	1040	7.50	5290	3.70	1930	2.35	545	3.35	1530	2.20	420	2.20	420	1.95	226	3.00	1140	2.00	263	4.30	2655
23	2.25	460	....	....	5.25	3190	3.20	1360	2.25	460	3.30	1470	2.10	340	2.10	340	1.90	191	2.70	855	2.00	263	3.70	1930
24	2.25	460	....	....	4.40	2650	2.90	1040	2.20	420	3.70	1930	2.50	675	2.00	263	1.90	191	2.60	765	2.00	263	3.40	1585
25	2.20	420	2.90	1040	4.90	2995	2.80	945	2.15	380	3.20	1360	2.25	460	3.20	1360	1.85	160	2.50	675	1.95	226	3.00	1140
26	2.20	420	....	....	4.15	2465	2.70	855	2.10	340	2.90	1040	2.10	340	3.00	1140	1.85	160	3.20	1360	1.95	226	2.80	945
27	....	...	....	....	3.95	2225	2.75	900	2.40	590	2.80	945	2.05	301	2.50	675	1.80	132	3.00	1140	2.00	263	2.70	855
28	....	...	....	....	3.50	1700	2.75	900	2.20	420	2.50	675	2.00	263	2.30	505	1.80	132	2.80	945	2.35	545	2.60	765
29	....	...	....	....	3.20	1360	2.65	810	2.00	263	2.30	505	2.10	340	2.20	420	1.80	132	2.60	765	5.65	3405	3.00	1140
30	....	...	....	....	3.00	1140	2.50	675	2.00	263	2.20	420	2.60	765	2.55	720	1.80	132	2.55	720	4.75	2900	2.70	855
31	....	..	....	....	2.85	990	....	...	2.15	380	....	...	3.00	1140	2.30	505	....	...	2.50	675	....	....	2.50	675

Note: River frozen Jan. 27 to Mar. 6; ice 0.6 ft. to 0.8 ft. thick. During this time gage was read to top of ice. On Feb. 15, the water overflowed ice and froze under gage, increasing the reading 0.2 ft.

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1906.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.50	675	2.50	675	2.00	263	5.20	3165	2.50	675	2.05	301
2	2.45	630	2.35	545	2.15	380	4.50	2725	2.70	855	2.10	340
3	2.70	855	2.45	630	2.35	545	4.40	2650	2.75	900	2.05	301
4	4.55	2975	2.30	505	2.90	1040	4.50	2725	2.60	765	2.05	301
5	3.70	1930	2.45	630	2.70	855	4.90	2995	2.60	765	2.00	263
6	3.05	1195	2.30	505	2.50	675	6.50	4080	2.45	630	4.10	2405
7	2.65	810	2.20	420	2.60	765	4.70	2870	2.50	675	4.90	2995
8	2.80	940	2.10	340	2.55	720	3.85	2105	2.40	590	3.35	1530
9	2.50	675	2.00	263	2.55	720	3.90	2165	2.30	505	2.70	855
10	2.25	460	2.05	301	2.50	675	5.05	3090	2.45	630	2.40	590
11	2.65	810	2.05	301	2.45	630	4.20	2475	2.35	545	2.25	460
12	2.60	765	2.10	340	2.70	855	3.60	1815	2.20	420	2.20	420
13	2.60	765	2.15	380	2.60	765	3.30	1470	2.25	460	2.15	380
14	2.50	675	2.00	263	2.60	765	3.10	1250	2.25	460	2.10	340
15	2.45	630	2.10	340	2.60	765	4.70	3170	2.10	340	2.10	340
16	2.65	810	2.10	340	2.45	630	4.00	2285	2.15	380	2.05	301
17	2.90	1040	2.05	301	2.55	720	3.50	1700	2.15	380	2.05	301
18	3.30	1470	2.05	301	2.50	675	3.20	1360	2.00	263	2.00	263
19	3.85	2105	2.00	263	2.50	675	3.00	1140	2.10	340	2.00	263
20	3.15	1305	2.10	340	2.45	630	2.80	945	2.05	301	2.10	340
21	3.20	1360	2.20	420	2.35	545	3.10	1250	1.95	226	2.40	590
22	3.30	1470	2.70	855	2.40	590	3.15	1305	2.00	263	2.20	420
23	9.90	8525	2.30	505	2.35	545	3.25	1415	1.95	226	2.25	460
24	4.70	2870	2.20	420	2.30	505	3.10	1250	1.80	132	2.15	380
25	4.10	2380	2.25	460	2.35	545	2.90	1040	1.85	160	2.05	301
26	3.50	1700	2.25	460	2.30	505	3.20	1360	1.85	160	2.00	263
27	3.20	1360	2.20	420	4.80	2930	3.20	1360	1.80	132	1.95	226
28	3.05	1190	2.15	380	7.40	5170	2.80	945	2.10	340	1.90	191
29	2.90	1040	....	...	5.60	3375	2.85	990	2.15	380	1.90	191
30	2.65	810	....	...	7.00	4680	2.50	675	2.10	340	1.80	132
31	2.70	855	....	...	7.70	5545	....	...	2.10	340	....	...

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.80	132	2.00	263	2.10	340	1.90	191	2.00	263	2.20	420
2	1.90	191	1.95	226	2.15	380	2.00	263	2.00	263	2.15	380
3	1.80	132	3.85	2105	2.10	340	1.95	226	1.90	191	2.30	505
4	1.85	160	2.80	945	2.00	263	1.90	191	1.80	132	2.20	420
5	1.80	132	2.40	590	1.95	226	2.10	340	1.80	132	2.20	420
6	1.75	112	2.15	380	1.90	191	2.10	340	1.80	132	3.35	1530
7	1.75	112	2.50	675	1.85	160	2.20	420	1.75	112	3.60	1815
8	1.70	93	4.65	2835	1.80	132	2.10	340	1.75	112	2.85	990
9	1.60	61	7.80	5675	1.80	132	1.95	226	1.75	112	2.70	855
10	1.60	61	8.80	7030	2.00	263	1.90	191	1.75	112	6.50	4080
11	1.65	76	4.90	2995	2.00	263	1.90	191	1.80	132	7.10	4800
12	1.60	61	3.65	1875	1.80	132	1.85	160	1.80	132	4.50	2725
13	1.60	61	3.20	1360	1.85	160	1.85	160	1.85	160	3.65	1875
14	1.60	61	2.80	945	2.00	263	1.85	160	1.85	160	3.35	1530
15	1.60	61	2.60	765	2.00	263	1.80	132	1.90	191	3.20	1360
16	1.60	61	2.45	630	1.90	191	1.80	132	1.90	191	3.80	2045
17	1.60	61	2.45	630	1.75	112	1.80	132	1.95	226	5.05	3090
18	1.70	93	2.40	590	1.90	191	1.80	132	2.70	855	5.10	3115
19	1.70	93	3.60	1815	1.90	191	1.80	132	3.10	1250	3.55	1760
20	1.65	76	4.00	2285	1.85	160	2.60	765	3.25	1415	3.40	1585
21	1.60	61	4.10	2405	1.80	132	2.45	630	2.90	1040	3.20	1360
22	1.75	112	3.30	1470	1.80	132	2.35	545	2.60	765	3.00	1140
23	2.60	765	2.95	1090	1.75	112	2.25	460	2.40	590	2.75	900
24	2.15	380	2.70	855	1.75	112	2.15	380	2.35	545	2.60	765
25	1.90	191	2.90	1040	1.70	93	2.05	301	2.30	505	2.50	675
26	1.75	112	2.65	810	1.70	93	2.00	263	2.25	460	2.50	675
27	1.75	112	2.60	765	1.75	112	2.00	263	2.20	420	2.60	765
28	1.70	93	2.55	720	1.80	132	2.00	263	2.20	420	2.90	1040
29	1.70	93	2.40	590	1.70	93	2.05	301	2.15	380	4.00	2285
30	1.90	191	2.30	505	1.75	112	2.00	263	2.10	340	4.70	2870
31	2.00	263	2.20	420	....	...	2.00	263	....	...	7.50	5290

Note: Discharge probably unaffected by ice conditions

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1907.

Day	January		February		March		April		May		June	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.80	3500	2.50	675	2.50	675	2.65	810	3.10	1250	3.10	1250
2	4.30	2565	2.70	855	3.50	1700	2.60	765	2.90	1040	5.55	3350
3	3.80	2045	5.30	3215	3.20	1360	2.55	720	3.00	1140	4.55	2765
4	3.50	1700	3.70	1930	3.00	1140	2.50	675	3.30	1470	3.65	1875
5	3.30	1470	3.25	1415	2.90	1040	2.45	630	3.10	1250	4.85	2960
6	3.05	1195	3.10	1250	2.90	1040	2.45	630	2.95	1090	4.55	2765
7	3.05	1195	2.95	1090	2.90	1040	2.55	720	3.20	1360	3.65	1875
8	3.50	1700	2.85	990	2.80	945	2.50	675	3.25	1415	3.70	1930
9	6.00	3640	2.75	900	2.70	855	2.45	630	8.55	6695	3.30	1470
10	4.20	2530	2.70	855	2.60	765	2.85	990	5.10	3115	3.05	1195
11	3.50	1700	2.60	765	2.80	945	2.90	1040	4.15	2465	6.25	3830
12	11.20	10290	2.55	720	3.00	1140	3.10	1250	3.80	2045	4.45	2690
13	7.50	5290	2.50	675	16.30	17215	3.00	1140	3.35	1530	4.75	2900
14	11.25	10360	2.50	675	18.10	19660	2.95	1090	3.15	1305	6.55	4140
15	8.15	6150	2.75	900	8.30	6355	2.90	1040	3.00	1140	5.15	3140
16	5.85	3535	2.70	855	6.10	3710	3.40	1585	2.90	1040	3.75	1990
17	5.40	3270	2.65	810	4.50	2725	3.30	1470	2.80	945	3.45	1645
18	6.40	3970	2.60	765	3.90	2165	3.20	1360	2.70	855	3.20	1360
19	12.20	11650	2.80	945	14.20	14365	3.10	1250	2.85	990	3.05	1195
20	9.00	7300	3.30	1470	10.40	9205	3.10	1250	4.40	2780	2.95	1090
21	5.50	3325	2.95	1090	6.10	3710	3.05	1195	3.65	1875	2.85	990
22	4.20	2530	2.70	855	5.10	3115	3.20	1360	3.50	1700	2.75	900
23	3.50	1700	2.70	855	4.00	2285	3.20	1360	3.30	1470	3.20	1360
24	3.10	1250	2.70	855	3.55	1760	4.60	3040	3.20	1360	2.85	990
25	3.30	1470	2.60	765	3.30	1470	3.60	1815	3.05	1195	2.75	900
26	3.10	1250	2.50	675	3.10	1250	3.25	1415	3.30	1470	2.55	720
27	2.90	1040	2.50	675	3.20	1360	3.25	1415	3.30	1470	2.45	630
28	2.90	1040	2.55	720	3.20	1360	3.20	1360	3.25	1415	2.30	505
29	2.80	945	....	...	3.10	1250	3.15	1305	3.15	1305	2.40	590
30	2.70	855	....	...	2.90	1040	3.10	1250	3.05	1195	2.45	630
31	2.60	765	....	...	2.75	900	....	....	2.90	1040	....	...

Day	July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.40	590	2.20	420	1.80	132	1.90	191	1.95	226	2.90	1040
2	2.85	990	2.10	340	1.75	112	1.85	160	1.90	191	2.85	990
3	2.50	675	2.00	263	1.90	191	1.80	132	4.95	3030	2.80	945
4	2.25	460	2.00	263	2.20	420	1.85	160	4.10	2405	2.75	900
5	2.30	505	2.00	263	2.20	420	1.90	191	3.60	1815	2.70	855
6	2.30	505	2.45	630	2.00	263	2.00	263	3.30	1470	2.60	765
7	2.30	505	2.40	590	1.85	160	1.95	226	6.00	3640	2.35	545
8	2.25	460	2.20	420	1.80	132	1.90	191	4.15	2465	2.45	630
9	2.15	380	2.20	420	1.80	132	2.25	460	3.65	1875	2.60	765
10	2.20	420	2.15	380	1.80	132	2.10	340	3.10	1250	6.20	3780
11	2.55	720	2.15	380	3.00	1140	2.05	301	2.90	1040	6.10	3710
12	4.95	3030	2.10	340	2.80	945	2.00	263	2.75	900	5.70	3430
13	3.25	1415	2.05	301	2.40	590	2.35	545	2.60	765	5.55	3350
14	2.70	855	2.00	263	2.20	420	2.00	263	2.55	720	5.25	3190
15	2.50	675	1.90	191	2.05	301	2.10	340	2.45	630	4.10	2405
16	2.40	590	1.80	132	2.00	263	2.00	263	2.35	545	3.95	2225
17	3.35	1530	1.90	191	2.00	263	1.95	226	2.30	505	3.75	1990
18	3.80	2045	1.90	191	2.00	263	1.95	226	2.40	590	3.55	1760
19	2.90	1040	1.90	191	2.15	380	1.95	226	2.95	1090	2.35	545
20	2.50	675	1.80	132	2.15	380	1.90	191	2.70	855	2.40	590
21	2.30	505	1.75	112	2.10	340	1.85	160	2.55	720	2.50	675
22	2.20	420	1.75	112	1.90	191	1.85	160	2.75	900	2.70	855
23	2.15	380	1.85	160	1.90	191	1.80	132	2.75	900	5.95	3605
24	2.15	380	2.80	945	2.10	340	1.75	112	2.70	855	5.25	3190
25	2.20	420	2.35	545	2.00	263	1.70	93	2.65	810	4.30	2565
26	4.10	2405	2.20	420	1.95	226	1.75	112	2.70	855	3.70	1930
27	3.50	1700	2.10	340	1.85	160	1.90	191	2.95	1090	3.40	1585
28	2.55	720	2.00	263	1.80	132	2.50	675	3.10	1250	4.60	3040
29	2.40	590	1.90	191	1.75	112	2.25	460	3.35	1530	4.70	3170
30	2.30	505	1.85	160	1.90	191	2.10	340	2.95	1090	3.80	2045
31	2.15	380	1.80	132	....	...	2.00	263	....	....	3.60	1815

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1908.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.40	1585	2.60	765	2.65	810	3.80	2045	2.70	855	2.85	990
2	3.00	1140	2.55	720	6.80	4440	4.30	2655	2.60	765	2.65	810
3	2.80	945	2.50	675	6.30	3875	3.50	1700	2.55	720	2.50	675
4	2.75	900	2.40	590	4.65	2835	3.20	1360	2.85	990	2.40	590
5	2.60	765	2.30	505	4.50	2725	2.95	1090	6.85	4500	2.20	420
6	2.65	810	2.25	460	7.25	4990	3.10	1250	5.70	3430	2.20	420
7	2.45	630	2.45	630	10.60	9475	3.00	1140	10.30	9065	2.15	380
8	2.25	460	2.35	545	7.05	4740	3.90	2165	7.20	4925	2.10	340
9	2.50	675	2.35	545	9.35	7780	4.80	2930	5.20	3165	2.05	301
10	2.35	545	2.35	545	5.60	3375	3.80	2045	4.10	2405	1.98	249
11	2.40	590	2.45	630	4.60	2800	7.55	5355	3.60	1815	1.93	213
12	7.10	4800	2.55	720	4.75	2900	4.70	2870	3.25	1415	1.93	213
13	5.80	3500	3.10	1250	5.00	3060	3.90	2165	3.05	1195	1.93	213
14	4.80	2930	4.90	2995	5.40	3270	3.50	1700	3.00	1140	1.88	179
15	4.40	2650	16.00	16810	4.90	2995	3.20	1360	3.60	1815	2.10	340
16	3.30	1470	7.95	5880	5.00	3060	3.20	1360	3.10	1250	2.05	301
17	2.95	1090	5.05	3090	4.25	2520	3.00	1140	3.00	1140	1.98	249
18	2.90	1040	4.80	2930	4.60	2800	3.10	1250	3.00	1140	1.98	249
19	2.60	765	3.80	2045	11.30	10425	4.15	2465	3.30	1470	1.93	213
20	2.35	545	3.05	1195	6.25	3830	3.20	1360	4.60	2800	1.88	179
21	2.65	810	2.95	1090	4.50	2725	3.10	1250	5.30	3215	2.30	505
22	3.20	1360	2.90	1040	3.75	1990	3.00	1140	5.80	3500	2.25	460
23	3.25	1415	2.80	945	3.50	1700	2.95	1090	3.50	1700	2.15	380
24	2.85	990	2.70	855	3.50	1700	2.90	1040	3.55	1760	2.10	340
25	2.55	720	2.55	720	3.05	1195	2.75	900	3.15	1305	2.20	420
26	3.00	1140	2.60	765	2.95	1090	2.80	945	3.05	1195	1.98	249
27	3.15	1305	2.60	765	2.85	990	2.65	810	2.90	1040	1.88	179
28	3.20	1360	2.60	765	2.80	945	2.55	720	2.80	945	1.78	124
29	2.70	855	2.45	630	3.50	1700	2.55	720	3.00	1140	1.78	124
30	2.45	630	....	...	3.25	1415	2.40	590	4.00	2285	1.73	105
31	2.40	590	....	...	3.80	2045	....	...	3.00	1140	....	...

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.73	105	1.68	87	1.48	34	1.48	34	1.38	18	1.38	18
2	1.73	105	1.58	56	1.48	34	1.48	34	1.38	18	1.38	18
3	1.73	105	1.58	56	1.43	25	1.48	34	1.38	18	1.43	25
4	1.73	105	1.53	44	1.43	25	1.48	34	1.38	18	1.43	25
5	1.73	105	1.53	44	1.38	18	1.48	34	1.33	12	1.43	25
6	1.73	105	1.53	44	1.38	18	1.43	25	1.33	12	1.43	25
7	1.73	105	1.73	105	1.38	18	1.43	25	1.33	12	1.48	34
8	1.73	105	1.68	87	1.38	18	1.43	25	1.33	12	1.58	56
9	1.68	87	1.68	87	1.38	18	1.43	25	1.33	12	1.48	34
10	1.68	87	1.58	56	1.33	12	1.38	18	1.33	12	1.53	44
11	1.63	71	1.53	44	1.33	12	1.38	18	1.38	18	1.58	56
12	1.63	71	1.53	44	1.33	12	1.38	18	1.38	18	1.68	87
13	1.63	71	1.48	34	1.33	12	1.38	18	1.38	18	1.63	71
14	1.73	105	1.48	34	1.33	12	1.38	18	1.38	18	1.58	56
15	1.83	150	1.43	25	1.33	12	1.38	18	1.38	18	1.68	87
16	1.83	150	1.43	25	1.33	12	1.38	18	1.43	25	1.73	105
17	1.78	124	1.43	25	1.33	12	1.38	18	1.43	25	1.88	179
18	1.78	124	1.63	71	1.28	6	1.38	18	1.48	34	2.85	990
19	1.68	87	1.98	249	1.28	6	1.38	18	1.53	44	2.55	720
20	1.68	87	1.73	105	1.28	6	1.38	18	1.58	56	2.15	380
21	1.68	87	1.58	56	1.28	6	1.38	18	1.58	56	1.93	213
22	1.93	213	1.53	44	1.28	6	1.38	18	1.58	56	1.88	179
23	1.83	150	1.53	44	1.28	6	1.38	18	1.53	44	1.88	179
24	2.95	1090	1.58	56	1.33	12	1.38	18	1.53	44	1.88	179
25	2.90	1040	1.58	56	1.33	12	1.43	25	1.53	44	1.88	179
26	2.65	810	1.53	44	1.28	6	1.43	25	1.48	34	1.78	124
27	2.45	630	1.53	44	1.28	6	1.43	25	1.43	25	1.68	87
28	2.20	420	1.53	44	1.28	6	1.43	25	1.43	25	1.73	105
29	2.10	340	1.58	56	1.28	6	1.43	25	1.43	25	1.73	105
30	1.93	213	1.53	44	1.48	34	1.43	25	1.38	18	1.68	87
31	1.78	124	1.48	34	....	..	1.43	25	....	..	1.93	213

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.83	150	2.00	263	3.30	1470	2.85	990	3.50	1700	2.15	380	2.00	263	1.63	71	1.78	124	1.53	44	1.93	213	1.83	150
2	1.73	105	2.40	590	4.10	2405	2.80	945	3.30	1470	2.35	545	2.05	301	1.58	56	1.73	105	1.53	44	1.93	213	1.78	124
3	1.93	213	2.30	505	4.50	2910	3.00	1140	3.10	1250	2.50	675	2.05	301	1.53	44	1.73	105	1.48	34	1.88	179	1.78	124
4	1.83	150	2.40	590	4.55	2975	3.50	1700	3.10	1250	2.35	545	1.98	249	1.48	34	1.73	105	1.48	34	1.88	179	1.78	124
5	1.78	124	2.60	765	4.10	2405	3.45	1645	3.00	1140	3.25	1415	1.98	249	1.48	34	1.88	179	1.48	34	1.88	179	1.78	124
6	1.88	179	2.85	990	3.50	1700	3.35	1530	2.75	900	4.10	2405	1.88	179	1.43	25	1.83	150	1.48	34	1.83	150	1.78	124
7	1.83	150	2.65	810	3.60	1815	3.05	1195	2.55	720	3.10	1250	1.83	150	1.43	25	1.73	105	1.43	25	1.73	105	1.93	213
8	1.78	124	2.40	590	4.00	2285	3.00	1140	2.55	720	3.05	1195	1.78	124	1.43	25	1.68	87	1.43	25	1.83	150	2.45	630
9	1.98	249	2.40	590	3.75	1990	2.80	945	2.55	720	3.05	1195	1.73	105	1.43	25	1.68	87	1.43	25	1.78	124	2.30	505
10	1.98	249	2.65	810	3.90	2165	2.80	945	2.60	765	3.05	1195	1.68	87	1.38	18	1.63	71	1.38	18	1.78	124	2.15	380
11	1.88	179	3.60	1815	3.40	1585	2.75	900	2.50	675	4.15	2465	1.68	87	1.38	18	1.63	71	1.58	56	1.78	124	2.10	340
12	1.98	249	3.60	1815	3.10	1250	2.65	810	2.30	505	3.25	1415	1.68	87	1.38	18	1.68	87	2.35	545	1.78	124	2.00	263
13	2.10	340	3.50	1700	2.90	1040	2.80	945	2.35	545	2.90	1040	1.68	87	1.38	18	1.68	87	2.15	380	1.78	124	2.20	420
14	2.05	301	3.35	1530	2.95	1090	6.30	3875	2.30	505	2.85	990	1.73	105	1.38	18	1.68	87	1.83	150	1.78	124	3.50	1700
15	3.50	1700	3.30	1470	2.85	990	4.50	2725	2.25	460	2.65	810	1.73	105	1.48	34	1.63	71	1.83	150	1.88	179	2.65	810
16	3.25	1415	5.40	3270	2.75	900	3.90	2165	2.20	420	2.55	720	1.68	87	3.65	1875	1.58	56	1.78	124	1.88	179	2.55	720
17	2.35	545	4.10	2405	2.65	810	3.25	1415	2.10	340	2.60	765	1.68	87	3.05	1195	1.58	56	1.73	105	1.88	179	2.30	505
18	2.35	545	3.35	1530	2.55	720	3.05	1195	2.10	340	2.35	545	1.68	87	2.80	945	1.53	44	1.68	87	1.88	179	2.30	505
19	2.15	380	3.25	1415	2.65	810	3.00	1140	2.05	301	2.35	545	1.68	87	2.60	765	1.53	44	1.83	150	1.88	179	2.20	420
20	2.40	590	3.35	1530	3.00	1140	3.70	1930	2.05	301	2.30	505	1.68	87	2.30	505	1.53	44	1.83	150	1.83	150	2.00	263
21	2.40	590	3.00	1140	2.80	945	5.30	3215	2.20	420	2.20	420	1.63	71	3.55	1760	1.53	44	1.78	124	1.83	150	2.05	301
22	2.60	765	2.85	990	2.80	945	6.80	4440	2.20	420	2.30	505	1.63	71	2.55	720	1.53	44	1.78	124	1.83	150	1.98	249
23	3.50	1700	3.25	1415	2.50	675	5.45	3300	2.20	420	2.25	460	1.68	87	2.30	505	1.58	56	2.00	263	1.83	150	1.88	179
24	4.60	3040	7.90	5810	2.50	675	4.50	2725	2.15	380	2.25	460	2.15	380	2.00	263	1.68	87	3.50	1700	1.83	150	1.88	179
25	3.50	1700	5.70	3430	2.60	765	3.75	1990	2.10	340	2.25	460	2.05	301	1.98	249	1.68	87	3.00	1140	1.83	150	2.05	301
26	3.30	1470	4.10	2405	2.90	1040	3.70	1930	2.05	301	2.20	420	1.98	249	1.88	179	1.68	87	2.30	505	1.78	124	2.15	380
27	2.55	720	3.90	2165	3.00	1140	3.10	1250	2.10	340	2.60	765	1.88	179	1.83	179	1.68	87	2.10	340	1.78	124	2.20	420
28	2.40	590	3.80	2045	3.00	1140	3.20	1360	2.40	590	2.45	630	1.78	124	1.88	150	1.63	71	2.10	340	1.78	124	2.20	420
29	2.20	420	....	....	3.05	1195	3.30	1470	2.20	420	2.30	505	1.68	87	1.93	213	1.63	71	2.10	340	1.83	150	2.15	380
30	2.05	301	....	....	3.00	1140	3.40	1585	2.10	340	2.20	420	1.68	87	1.93	213	1.58	56	2.05	301	1.83	150	2.25	460
31	1.95	226	....	....	2.90	1040	....	....	2.10	340	....	...	1.63	71	1.88	179	....	..	1.98	249	....	...	2.25	460

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.35	535	2.80	967	7.00	4720	2.10	331	2.80	967	2.75	916	2.25	449	1.60	61	1.75	118	1.40	19	1.50	36	1.70	95
2	3.20	1388	2.75	916	6.25	3960	2.05	295	2.65	816	3.30	1497	2.25	449	1.60	61	1.80	141	1.40	19	1.50	36	1.70	95
3	10.20	8880	2.85	1018	5.30	3140	2.00	260	2.55	719	3.20	1388	2.20	408	1.55	48	1.80	141	1.40	19	1.50	36	1.70	95
4	6.05	3760	2.75	916	4.80	2785	2.00	260	2.45	625	3.00	1175	2.20	408	1.55	48	2.05	295	1.35	14	1.45	27	1.70	95
5	3.75	1995	2.50	671	4.60	2660	2.10	331	2.45	625	3.20	1388	2.20	408	1.50	36	2.05	295	1.35	14	1.45	27	1.70	95
6	4.55	2630	2.25	449	4.50	2600	2.05	295	2.35	535	4.10	2315	2.15	369	1.50	36	1.90	196	1.35	14	1.45	27	1.90	196
7	4.60	2660	2.10	331	4.00	2235	2.00	260	2.30	491	3.35	1601	2.10	331	1.50	36	1.80	141	1.35	14	1.45	27	1.90	196
8	3.85	2095	2.00	260	3.65	1890	2.00	260	2.25	449	3.00	1175	2.05	295	1.50	36	1.70	95	1.50	36	1.45	27	1.90	196
9	3.20	1388	2.55	719	3.40	1608	2.00	260	2.40	579	2.90	1070	2.10	331	1.50	36	1.65	78	1.50	36	1.45	27	1.90	196
10	2.80	967	2.90	1070	3.15	1334	2.00	260	2.40	579	3.75	1995	2.10	331	1.50	36	1.60	61	1.45	27	1.45	27	b 1.90	196
11	2.60	767	2.70	866	2.95	1122	2.00	260	2.45	625	3.90	2145	2.10	331	1.50	36	1.60	61	1.45	27	1.45	27	1.90	196
12	2.70	866	2.55	719	2.85	1018	1.95	228	2.95	1122	3.65	1890	2.05	295	1.50	36	1.60	61	1.45	27	1.45	27	1.90	196
13	2.50	671	2.45	625	2.75	916	1.95	228	2.85	1018	3.35	1601	2.00	260	1.50	36	1.60	61	1.45	27	1.45	27	1.90	196
14	2.40	579	2.40	579	2.70	866	1.90	196	2.95	1122	3.10	1281	2.20	408	1.50	36	1.60	61	1.40	19	1.45	27	1.90	196
15	2.40	579	2.40	579	2.60	767	1.90	196	2.75	916	2.90	1070	2.10	331	1.60	61	1.60	61	1.40	19	1.45	27	1.90	196
16	2.40	579	4.50	2600	2.55	719	1.90	196	2.60	767	2.80	967	2.00	260	1.60	61	1.55	48	1.40	19	1.45	27	1.90	196
17	2.40	579	5.15	3027	2.50	671	1.90	196	2.45	625	3.35	1601	1.90	196	1.55	48	1.55	48	1.40	19	1.45	27	1.90	196
18	a 9.90	8460	4.45	2567	2.40	579	1.85	168	2.35	535	3.05	1228	1.85	168	1.55	48	1.55	48	1.40	19	1.45	27	1.90	196
19	7.00	4720	3.45	1664	2.35	535	1.85	168	2.40	579	12.60	12240	1.80	141	1.70	95	1.55	48	1.40	19	1.55	48	1.90	196
20	4.20	2390	3.05	1228	2.60	767	1.85	168	2.35	535	6.40	4110	1.75	118	1.65	78	1.50	36	1.40	19	1.55	48	1.90	196
21	6.90	4610	3.40	1608	2.55	719	1.90	196	2.35	535	4.20	2390	1.65	78	1.65	78	1.50	36	1.40	19	1.55	48	1.90	196
22	5.10	2990	6.80	4510	2.50	671	3.10	1281	2.30	491	3.75	1995	1.60	61	1.65	78	1.50	36	1.40	19	1.55	48	1.90	196
23	3.75	1995	4.70	2720	2.50	671	3.15	1334	2.25	449	3.20	1388	1.60	61	1.60	61	1.45	27	1.50	36	1.55	48	1.90	196
24	3.30	1497	3.55	1777	2.45	625	2.90	1070	2.35	535	2.90	1070	1.60	61	1.60	61	1.45	27	1.50	36	1.55	48	1.90	196
25	3.10	1281	3.20	1388	2.40	579	6.10	3815	2.10	331	2.90	1070	1.60	61	1.60	61	1.45	27	1.50	36	1.70	95	2.00	260
26	3.00	1175	3.20	1388	2.40	579	4.50	2600	2.85	168	2.80	967	1.60	61	1.55	48	1.45	27	1.50	36	1.70	95	2.00	260
27	4.00	2235	3.60	1835	2.35	535	3.70	1945	2.65	816	2.70	866	1.60	61	1.55	48	1.45	27	1.50	36	1.70	95	2.00	260
28	3.30	1497	6.40	4110	2.30	491	3.60	1835	2.60	767	2.65	816	1.60	61	1.50	36	1.45	27	1.50	36	1.70	95	2.00	260
29	3.05	1228	....	....	2.25	449	3.45	1664	2.55	719	2.45	625	1.55	48	1.50	36	1.45	27	1.50	36	1.70	95	2.40	579
30	2.95	1122	....	....	2.20	408	3.15	1334	2.50	671	2.30	491	1.70	95	1.50	36	1.40	19	1.50	36	1.70	95	5.60	3380
31	2.85	1018	....	....	2.15	369	....	....	2.50	671	....	...	1.60	61	1.50	36	....	..	1.50	36	....	..	3.50	1720

a. Max. 10.80 = 9720 sec.-ft. b. River frozen Dec. 10 to 23; gage heights interpolated.

Daily Gage Heights and Discharges of Casselman River at Confluence, Pa., for 1911.

Day	January		February		March		April		May	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.09	1270	4.08	2299	3.02	1196	2.86	1029	2.65	817
2	3.94	2181	3.58	1812	2.97	1144	2.76	926	2.95	1122
3	5.49	3308	3.18	1367	2.87	1040	2.66	827	2.85	1019
4	3.94	2181	3.08	1260	2.77	937	3.01	1186	2.75	916
5	3.09	1270	2.98	1154	2.72	886	6.86	4570	2.65	817
6	2.84	1008	2.88	1050	2.92	1091	8.96	7152	2.55	719
7	2.69	856	2.83	998	2.87	1040	5.71	3468	2.45	625
8	2.59	757	2.78	947	2.87	1040	4.36	2507	2.35	535
9	2.54	709	2.83	998	2.82	987	4.16	2360	2.30	491
10	2.49	662	2.73	896	2.77	937	4.01	2243	2.25	449
11	2.69	856	2.63	797	2.77	937	3.71	1955	2.15	369
12	3.39	1597	2.58	748	2.77	937	3.41	1619	2.10	331
13	11.74	11960	2.58	748	2.87	1040	3.21	1399	2.05	295
14	7.49	5284	3.03	1207	2.97	1144	3.16	1345	2.05	295
15	6.09	3805	3.98	2217	3.22	1409	3.56	1788	2.05	295
16	4.39	2528	3.38	1475	3.12	1302	3.16	1345	2.05	295
17	3.49	1709	3.18	1367	3.07	1249	3.06	1239	2.00	260
18	3.19	1377	2.98	1154	2.97	1143	2.96	1133	2.00	260
19	2.99	1164	2.83	998	3.22	1409	2.86	1029	1.95	228
20	2.79	957	2.73	896	3.97	2208	3.36	1562	1.95	228
21	2.79	957	2.68	846	3.77	2018	3.21	1399	1.95	228
22	2.69	856	2.62	787	3.62	1857	3.21	1399	1.95	228
23	2.59	757	2.62	787	3.52	1753	3.66	1901	1.95	228
24	2.54	709	2.78	947	3.42	1630	3.26	1543	2.45	625
25	2.44	616	2.88	1050	3.37	1573	3.16	1345	2.35	535
26	2.79	957	3.18	1367	3.32	1519	3.06	1239	2.25	449
27	3.89	2136	3.68	1923	3.27	1464	2.96	1133	2.10	331
28	3.99	2226	3.38	1475	3.17	1356	2.86	1029	1.95	228
29	4.54	2624	....	....	3.12	1302	2.76	926	1.95	228
30	11.79	12660	....	....	3.07	1249	2.66	827	2.45	625
31	5.99	4709	....	....	2.97	1144	....	....	2.25	449

Estimated Monthly Discharge of Casselman River at Confluence, Pa.

[Drainage area, 448 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
October	61	14	31	0.069	0.080
November	49	20	31	0.069	0.080
1905					
March	9205	990	...	.....	.....
April	1930	675	952	2.115	2.360
May	1585	263	633	1.407	1.622
June	3430	263	912	2.027	2.262
July	1815	263	687	1.527	1.760
August	3270	191	754	1.675	1.931
September	2960	132	549	1.220	1.361
October	3710	76	654	1.453	1.675
November	3405	226	586	1.302	1.452
December	6490	340	1289	2.864	3.301

Estimated Monthly Discharge of Casselman River at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1906					
January	8525	460	1454	3.231	3.725
February	855	263	425	0.944	0.983
March	5545	263	1248	2.773	3.197
April	4080	675	1926	4.280	4.775
May	900	132	438	0.973	1.121
June	2995	132	548	1.218	1.359
July	765	61	138	0.307	0.354
August	7030	226	1461	3.247	3.743
September	380	93	183	0.407	0.454
October	765	132	282	0.627	0.723
November	1415	112	391	0.869	0.970
December	5290	380	1712	3.804	4.385
The year	8525	61	851	1.890	25.789
1907					
January	11650	765	3265	7.255	8.364
February	3215	675	1009	2.242	2.335
March	19660	675	3469	7.709	8.888
April	3040	630	1174	2.609	2.911
May	6695	855	1626	3.613	4.165
June	4140	505	1788	3.973	4.432
July	3030	380	854	1.898	2.188
August	945	112	312	0.693	0.798
September	1140	112	306	0.680	0.759
October	675	93	253	0.562	0.648
November	3640	191	1200	2.666	2.975
December	3780	545	1900	4.222	4.867
The year	19660	93	1430	3.177	43.330
1908					
January	4800	460	1258	2.796	3.224
February	16810	460	1762	3.916	4.224
March	10425	810	3232	7.182	8.280
April	5355	590	1620	3.600	4.017
May	9065	720	2104	4.676	5.391
June	990	105	347	0.771	0.860
July	1090	71	231	0.513	0.591
August	249	25	60	0.133	0.153
September	34	6	14	0.031	0.034
October	34	18	23	0.051	0.059
November	56	12	26	0.058	0.065
December	990	18	151	0.336	0.387
The year	16810	6	902	2.005	27.285
1909					
January	3040	105	628	1.396	1.610
February	5810	263	1585	3.522	3.667
March	2975	675	1392	3.093	3.565
April	4440	810	1751	3.891	4.341
May	1700	301	624	1.387	1.599
June	2465	380	855	1.900	2.120
July	380	71	149	0.331	0.381
August	1875	18	334	0.742	0.855
September	179	44	82	0.182	0.203
October	1700	18	246	0.547	0.631
November	213	105	153	0.340	0.379
December	1700	124	393	0.873	1.006
The year	5810	18	683	1.519	20.357

Estimated Monthly Discharge of Casselman River at Confluence, Pa.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1910					
January	9720	535	2166	4.835	5.574
February	4510	260	1468	3.277	3.413
March	4720	369	1322	2.951	3.402
April	3815	168	729	1.625	1.843
May	1122	168	657	1.466	1.666
June	12240	491	1811	4.042	4.509
July	449	48	226	0.504	0.581
August	95	36	50	0.112	0.129
September	295	19	78	0.174	0.194
October	36	14	25	0.056	0.066
November	95	27	46	0.103	0.115
December	3380	95	352	0.786	0.906
The year	12240	14	744	1.494	22.398
1911					
January	12660	616	2408	5.375	6.197
February	2299	748	1199	2.676	2.787
March	2208	886	1256	2.704	3.117
April	7152	827	1781	3.975	4.434
May	1122	228	468	1.044	1.204

DUNKARD CREEK AT BOBTOWN, PA.

This station, situated on the single-span covered wooden bridge at Bobtown, Greene Co., Pa., about 3 miles from the mouth of Dunkard Creek, was established October 14, 1909, by K. C. Grant, for the Water Supply Commission of Pennsylvania and the Flood Commission of Pittsburgh.

A staff gage, 12 feet long, is bolted to downstream wing of left abutment. The zero of the gage is 2.64 feet below the shelf on top of second course from bottom, third stone in from the face.

Measurements are taken from the downstream side of the bridge during medium and high stages, and by wading during low stages. The initial point for soundings is the top of bridge-seat, left abutment.

The channel is straight above and below the station for a distance of over 500 feet. The bed of the creek is, for the most part, solid rock. There is a deep, quiet pool under the bridge with a very sluggish flow at low stages. The creek goes dry every summer. Both banks are high and do not overflow. There is an extreme range of about 10 feet between high and low water.

The gage is read twice daily by Frank South.

The drainage area above the station is about 225 square miles.

Discharge Measurements of Dunkard Creek at Bobtown, Pa.

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1909		*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Oct. 14a	K. C. Grant	...	...	....	....	0.40
1911						
July 14a	F. E. Langenheim	33	19	0.48	0.96	8.90

a. Wading measurement.

Note. This stream and Ten Mile Creek went dry in September, 1908.

Daily Gage Heights, in Feet, of Dunkard Creek at Bobtown, Pa.

Day	1910 Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.94	2.10	3.88	1.08	1.62	1.70	1.34	1.34	0.74	0.68	0.67	1.66
2	1.41	2.02	3.37	1.13	1.50	1.97	1.27	1.24	0.78	0.64	0.70	1.47
3	3.24	2.40	2.88	1.09	1.44	2.16	e 3.70	1.14	1.26	0.62	0.70	1.40
4	3.05	2.90	2.55	1.09	1.43	2.01	3.04	1.04	1.96	0.60	0.70	1.33
5	2.30	2.76	2.35	1.20	1.43	1.83	2.22	0.96	1.57	0.60	0.69	1.30
6	4.90	2.34	2.21	1.17	1.35	2.00	1.85	0.90	1.47	0.59	0.68	1.29
7	3.75	1.90	2.07	1.29	1.27	2.02	4.43	0.85	1.46	0.60	0.68	1.39
8	2.40	2.06	1.97	1.22	1.25	1.84	3.85	0.81	1.32	0.59	0.68	1.35
9	2.29	1.85	1.86	1.20	1.28	1.70	2.60	0.79	1.30	0.58	0.67	1.43
10	1.95	1.86	1.72	1.13	1.32	2.09	2.08	0.78	1.24	0.57	0.68	1.52
11	1.88	1.79	1.67	1.10	1.42	2.50	1.94	0.80	1.20	0.55	0.69	1.55
12	1.80	1.99	1.61	1.14	2.59	2.87	1.74	0.78	1.14	0.52	0.70	1.49
13	1.83	2.13	1.56	1.06	2.40	2.40	2.35	0.73	1.06	0.52	0.70	1.45
14	5.90	2.09	1.52	1.01	2.28	2.12	3.13	0.69	1.12	0.50	0.70	1.52
15	3.80	1.84	1.49	1.04	2.28	1.97	2.28	0.68	1.16	0.49	0.70	1.56
16	2.87	b3.92	1.43	1.10	2.15	1.84	1.98	0.64	1.10	0.50	0.70	1.56
17	2.68	4.45	1.39	1.05	1.54	1.72	1.86	0.62	1.05	0.50	0.70	1.56
18	a6.75	3.32	1.35	1.03	1.57	1.62	1.74	0.60	1.00	0.50	0.70	1.62
19	4.80	2.52	1.32	1.03	1.94	d3.40	1.58	0.72	0.94	0.51	0.70	1.82
20	3.09	2.48	1.30	1.11	1.72	2.41	1.42	0.70	0.90	0.51	0.70	2.59
21	4.80	3.97	1.30	1.31	1.75	1.93	1.32	0.64	0.88	0.52	0.70	3.00
22	4.25	4.95	1.30	1.86	2.08	1.68	1.26	0.59	0.86	0.62	0.70	2.68
23	3.05	3.65	1.28	1.84	1.90	1.55	1.18	0.56	0.82	0.64	0.72	2.44
24	2.75	2.74	1.28	1.87	1.74	1.47	1.14	0.55	0.77	0.64	0.70	f4.14
25	2.38	2.42	1.28	2.36	1.94	1.37	1.07	0.53	0.71	0.62	0.71	3.04
26	2.15	2.35	1.20	2.40	c3.00	1.28	1.01	0.58	0.66	0.62	0.72	2.48
27	4.14	2.34	1.15	2.35	2.29	1.22	1.00	0.56	0.66	0.65	0.72	2.17
28	3.50	3.50	1.13	2.08	1.96	2.07	0.98	0.54	0.79	0.68	0.90	1.98
29	2.92	---	1.12	1.86	1.74	1.64	0.94	0.52	0.77	0.68	1.83	f3.96
30	2.54	---	1.13	1.75	1.68	1.46	1.19	0.50	0.68	0.67	1.98	4.44
31	2.36	---	1.11	---	1.67	---	1.16	0.56	---	0.66	---	3.12

Day	1911 Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	---	2.14	2.13	2.52	1.43	1.19	0.51	2.45	2.47	1.47	1.73
2	3.14	---	2.07	2.20	4.40	1.25	1.10	0.51	1.98	4.20	1.45	1.79
3	3.06	2.50	1.98	2.20	2.91	1.24	1.02	0.51	1.65	3.67	1.41	1.78
4	2.70	3.45	1.90	2.62	2.54	1.23	0.94	0.55	1.46	2.81	1.35	1.83
5	2.30	3.25	1.86	4.80	2.28	1.19	0.88	0.52	1.30	2.41	1.32	1.73
6	2.20	2.94	1.94	4.20	2.08	1.20	0.82	0.50	1.58	2.10	1.38	1.69
7	2.06	3.30	2.31	3.65	1.93	1.17	0.83	0.50	3.25	3.90	2.44	1.72
8	2.02	3.10	2.35	3.25	1.82	1.88	0.78	0.52	2.36	3.82	2.35	1.65
9	2.35	2.98	3.33	3.90	1.75	1.50	0.72	0.51	2.61	2.85	2.10	1.65
10	2.15	2.70	3.50	3.25	1.70	1.34	0.70	0.50	3.17	2.50	1.92	1.69
11	2.15	2.33	2.95	2.67	1.64	1.23	0.68	0.55	2.97	3.15	1.79	1.75
12	2.16	2.23	2.55	2.49	1.56	1.20	0.91	0.52	2.48	3.60	1.80	1.81
13	6.25	2.12	2.39	2.49	1.47	1.15	0.94	0.67	2.05	2.90	3.25	1.94
14	4.40	2.07	2.19	2.47	1.41	1.11	0.91	0.73	1.80	2.52	2.65	2.05
15	3.70	2.05	2.10	3.82	1.38	1.15	0.90	1.37	3.58	2.42	2.37	2.80
16	3.08	1.93	2.03	3.13	1.35	1.12	0.83	1.62	5.05	2.64	2.32	4.35
17	2.61	1.83	1.89	2.72	1.28	1.11	0.82	1.30	3.92	2.47	2.18	3.70
18	2.26	1.85	1.90	2.42	1.26	1.43	0.76	1.35	2.58	5.40	3.03	2.90
19	2.10	2.40	1.95	2.26	1.21	2.31	0.74	1.12	2.68	3.47	3.30	2.51
20	1.98	3.39	2.40	2.70	1.19	1.83	0.70	0.97	2.20	2.90	2.65	2.25
21	1.98	3.45	2.35	2.76	1.15	1.83	0.68	0.87	1.95	2.45	2.38	2.17
22	2.28	2.94	2.35	3.00	1.10	1.36	0.64	0.80	2.32	2.27	2.16	2.27
23	2.34	2.71	2.18	4.00	1.08	1.20	0.61	0.75	2.14	2.07	2.01	2.31
24	2.21	2.67	2.07	3.15	1.06	1.12	0.62	0.73	1.82	1.95	2.02	2.50
25	2.31	2.64	1.78	2.69	1.02	1.64	0.62	0.85	1.67	1.78	2.39	2.80
26	3.04	2.52	1.72	2.44	1.00	1.81	0.61	1.12	1.54	1.67	2.31	3.00
27	3.75	2.49	1.74	2.23	0.99	1.50	0.60	1.35	1.44	1.65	2.20	5.00
28	4.40	2.31	1.73	2.05	0.96	1.52	0.58	1.15	2.02	1.54	2.12	3.44
29	3.70	---	1.68	1.97	0.95	1.53	0.56	1.78	3.79	1.45	2.06	2.70
30	g	---	1.74	2.09	0.98	1.34	0.55	3.47	3.22	1.46	1.97	2.53
31	---	---	1.95	---	1.25	---	0.54	3.20	---	1.45	---	---

a. Max. 8.00 at 5 P.M.
b. Max. 5.60 at 5 P.M.
c. Max. 3.40 at 5 A.M.
d. Max. 3.9- at 12 noon.
e. Max. 5.52 at 12:30 P.M.
f. Max. 5.00 at 7:30 P.M. on 24th and 11 A.M. on 29th.
g. Gage carried away. Maximum gage height about 10 feet.

CHEAT RIVER NEAR MORGANTOWN, W. VA.*

This station, situated on the highway bridge at Uneva, W. Va., 10 miles above the mouth, was maintained from July 8 to December 30, 1899, July 1 to December 29, 1900, and August 21, 1902, to December 31, 1905, and was re-established November 18, 1908, by F. W. Scheidenhelm, through whose courtesy the 1908 and 1909 discharge measurements and gage heights have been furnished to the U. S. Geological Survey and to the Flood Commission of Pittsburgh for publication.

The staff gage for this station was originally located about 100 feet above the present location of Ice's Ferry bridge at Uneva, W. Va., about 6 miles northeast of Morgantown and 10 miles above the mouth of Cheat River. The 1899 measurement was made from a cable which was located at the gage. During 1900 the cable was moved downstream about a mile and all subsequent measurements were made at the new cable location except those stated to have been made at wading sections or at Ice's Ferry bridge. The first four measurements made during 1899 to 1901 were referred to the staff gage immediately above the present location of Ice's Ferry bridge.

On August 20, 1902, a new inclined and vertical staff gage was installed about 275 feet below the new cable section. The readings were made on the inclined section below 6.5 feet. The new gage was set to read the same as the original gage at 1.8 feet. On September 28, 1904, the inclined portion of this staff gage was found to read 0.35 foot too high and the vertical section 0.15 foot too high. Both sections were accordingly lowered. On September 28, 1904, a chain gage was established on Ice's Ferry bridge to read the same as the second staff gage at 1.85 feet. The chain measures 41.03 feet from marker to bottom of weight. Both gages were maintained from September 28, 1904, to December 31, 1905. The staff gage was maintained from November 18, 1908, to May 8, 1909, and the chain gage has been maintained from January 21, 1909, to date. From these simultaneous gage readings the following gage relation has been determined.

Chain gage	Staff gage	Chain gage	Staff gage
Feet	*Feet*	*Feet*	*Feet*
1.5	1.52	6.5	7.69
2.0	2.00	7.0	8.28
2.5	2.52	7.5	8.87
3.0	3.11	8.0	9.43
3.5	3.78	8.5	9.98
4.0	4.46	9.0	10.53
4.5	5.15	9.5	11.06
5.0	5.82	10.0	11.59
5.5	6.47	10.5	12.11
6.0	7.09	11.0	12.65

All discharge measurements and gage heights from 1902 to 1909, as published below, are referred to the second staff gage. All gage heights from 1902 to September 28, 1904, have been reduced to the gage zero established September 28, 1904. Gage heights for 1899-1900 are referred to the original staff gage.

The following are the bench marks to which the chain gage is referred. The top of northeast anchor bolt in north end of masonry footing of east pier has an elevation of 9.33 feet above the zero of the gage. The chiselled rod seat, 2 feet above the ground, in corner stone of northwest corner of east abutment, has an elevation of 16.67 feet above the zero of the gage. This seat is on the west face of abutment, 8 inches from the north edge of face.

*Description of station largely furnished by U. S. Geological Survey.

The original staff gage and the chain gage are located in a deep pool, with large islands about one-fourth mile above and below the station. The second staff gage is also located in a deep pool of somewhat smaller dimensions than at the original location. It is situated nearly one-fourth mile below a large island and a short distance above a small island. Both pools are controlled by permanent rock reefs. Water was diverted around the lower gage for milling prior to 1908. The quantity thus diverted was relatively small, (see table of discharge measurements), except at low stages, and has been disregarded in the following computations of discharge, but should, however, be taken into consideration in making use of the tables to determine the run-off in the Cheat River drainage basin. No tributaries of any importance enter Cheat River near the gaging station.

Large ice jams sometimes occur at this station. In January, 1904, the ice piled up from 8 to 10 feet above normal low-water stage, thus greatly affecting the relation of gage height to discharge. For the occurrence of other periods of ice effect, as determined by observer's records and climatological reports, see gage height table footnotes. The discharge for these periods has been estimated, and it is assumed that the open-channel rating applies for all other winter periods.

The curves developed are very satisfactory and the daily and monthly discharge values given in the following table are considered very good, with the possible exception of those for 1902-3, for which period there is some doubt about the elevation of the inclined gage. However, as the two measurements made during 1902-3 plot practically on the 1904-1909 discharge curve, when their gage heights are increased 0.35 foot, it is evident either that the inclined gage was set incorrectly at the time of its installation by the amount of the error in the gage (0.35 foot) discovered during 1904, or else that conditions of flow were different in these two years from what they have been since. In either event the correction of all gage heights for 1902-3 in accordance with the discrepancies found September 28, 1904, will yield essentially correct results for these years, and these corrections have accordingly been made.

The discharge for low stages during 1899-1900 is also somewhat open to question. It has been impossible as yet to determine the period when Ice's Ferry bridge was erected. The somewhat conflicting statements obtained seem to indicate that the bridge was built during 1900 or 1901. In any event it is probable that both the measurements made during 1901 were affected by the backwater from the bridge. This backwater effect is, however, very slight at low stages, owing to the deep, wide pool in which the gage is located. The two rating curves probably converge to a common curve at some point above the stage of zero flow. Hence at low stages the 1899-1900 discharges may be too high.

The gage is read daily by C. F. Baker.

The drainage area above the station is 1380 square miles.

Discharge Measurements of Cheat River near Morgantown, W. Va.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1899			Feet	Sq. ft.	Ft. per sec.	Feet	Sec.-ft
July	8a	E. G. Paul	367	2160	2.60	2.60	1150
1900							
July	25b	do	292	1240	....	2.80	c1400
1901							
July	26d	do	282	1060	....	2.30	710
Nov.	5e	do	139	167	....	1.45	222
1902							
Aug.	20b	do	275	940	....	2.10	299
1903							
Sept.	1b	do	283	1090	....	2.65	f672
1904							
July	6b	Hoyt and Hall	300	1230	....	2.95	773
Sept.	16g	R. T. Taylor	275	887	....	2.00	136
1905							
Mar.	17h	Grover and Morse	388	2750	....	5.56	5720
Mar.	17b	do	320	1950	....	5.62	5940
1908							
Nov.	18i	Scheidenhelm and Custer	83	74	....	1.61	131
Dec.	9j	L. B. Custer	171	141	....	1.86	223
1909							
Jan.	21k	Horton and Scheidenhelm	385	2450	....	4.16	2410
Apr.	28h	Scheidenhelm and Hammel	395	2900	....	5.16	4520
June	6h	do	412	3380	....	7.26	10600
June	7h	V. F. Hammel	397	2880	....	5.62	6140
July	12n	do	106	132	....	2.34	358
Aug.	19h	Scheidenhelm and Hammel	386	2460	....	4.06	2180
Aug.	19h	do	385	2390	....	3.99	1950

a. Measurement made at original cable section above the present Ice's Ferry bridge.

b. Measurement made at second cable section about 1 mile below the bridge.

c. Mill-race discharge of 25 second-feet included in total discharge of the river.

d. Measurement at second cable section about 1 mile below the bridge. Somewhat affected by new Ice's Ferry bridge, which was erected below the original gage during 1900 to 1901. Mill-race discharge of 6 second-feet included in total discharge of the river.

e. Measurement made at wading section, 700 feet above the second cable location. Somewhat affected by new Ice's Ferry bridge, which was erected just below the original gage during 1900 to 1901.

f. Mill-race discharge of 10 second-feet not included in value of discharge given.

g. Measurement at second cable section. Considered inaccurate on account of low velocity, and not used in developing the discharge curve.

h. Measurement made at Ice's Ferry bridge. Gage height was read on the chain gage and reduced to the corresponding reading on the staff gage.

i. Measurement at wading section, three-eighths mile above the bridge.

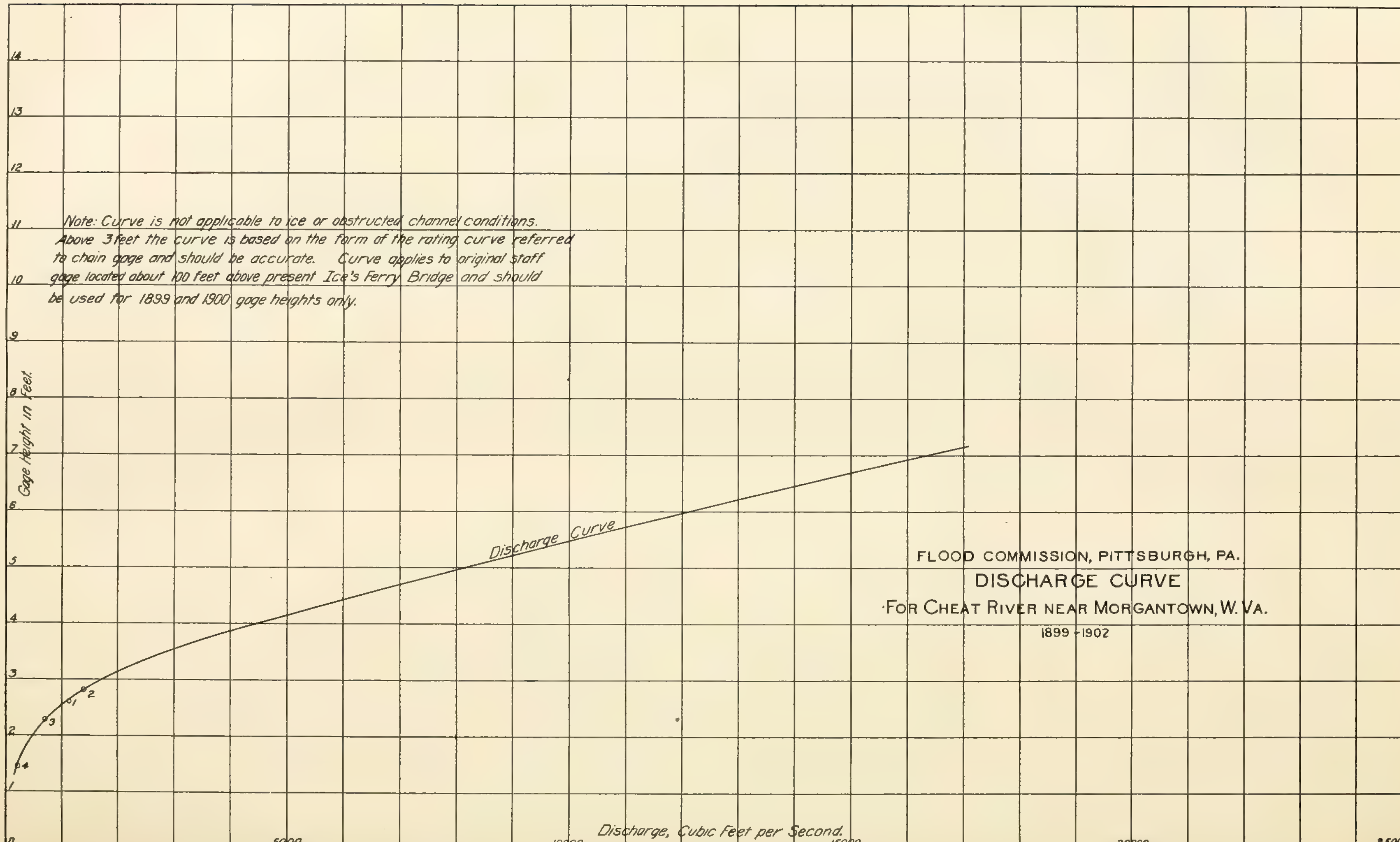
j. Measurement at wading section, one-fourth mile below the cable.

k. Measurement at Ice's Ferry bridge.

n. Measurement at wading section, one-half mile above the bridge. Gage height read on chain gage and reduced to corresponding reading on the staff gage.

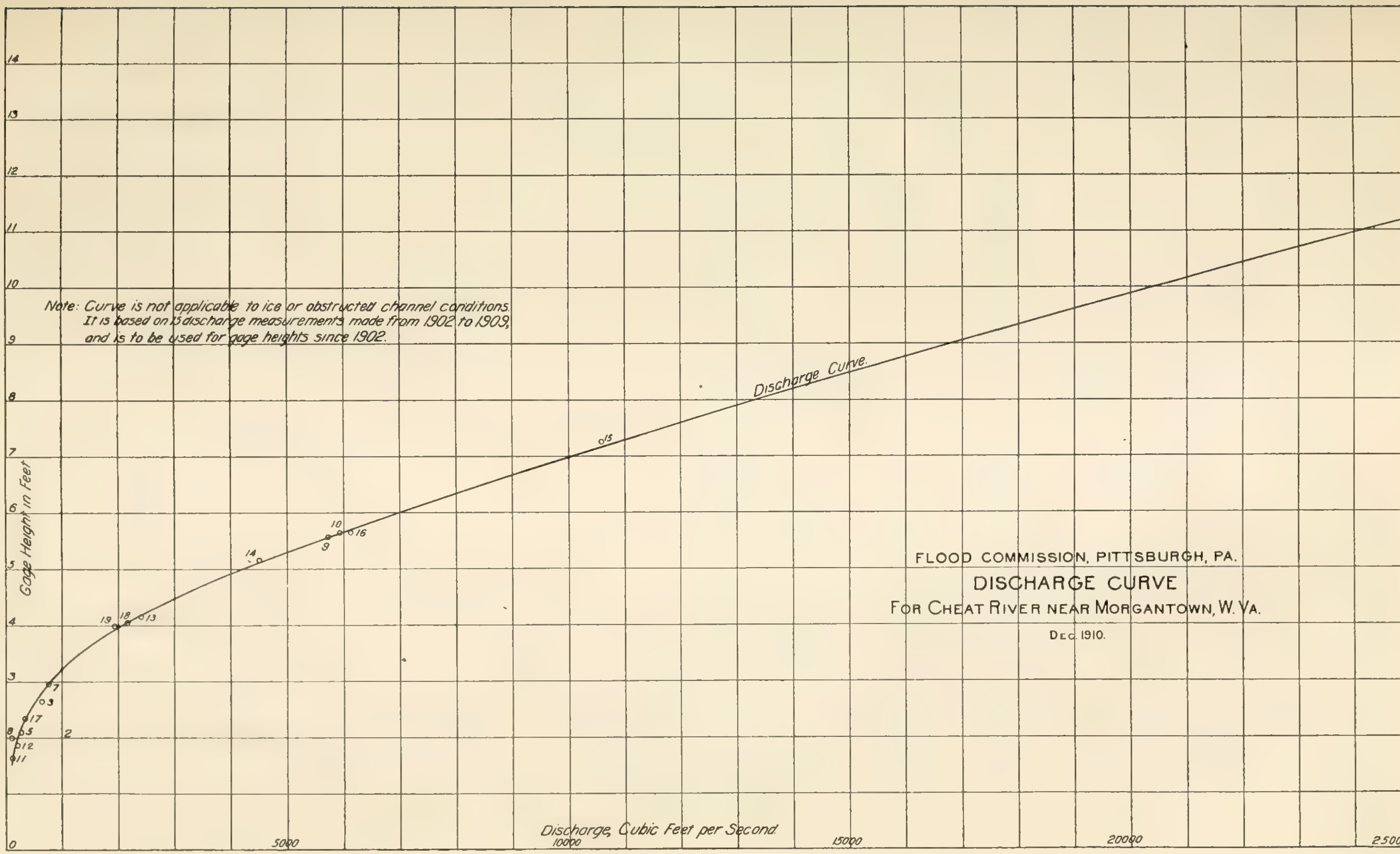
Note: Gage heights 1899–1901 refer to original staff gage established July 8, 1899, above the present Ice's Ferry bridge. Gage heights 1902-1905 and 1908–1909 refer to the staff gage established August 21, 1902, about 1 mile below the bridge, and have been reduced to the present datum. Gage heights of measurements read on the chain gage have been reduced to the corresponding reading on the staff gage. All other gage heights were read directly on the staff gage.

PLATE 114



FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR CHEAT RIVER NEAR MORGANTOWN, W. VA.
1899-1902
Note: Curve is not applicable to ice or obstructed channel conditions.
Above 3 feet the curve is based on the form of the rating curve referred to chain gage and should be accurate. Curve applies to original staff gage located about 100 feet above present Ice's Ferry Bridge and should be used for 1899 and 1900 gage heights only.
Discharge Curve
Gage Height in Feet.
Discharge, Cubic Feet per Second.
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5000
10000
15000
20000
25000

PLATE 115



Note: Curve is not applicable to ice or obstructed channel conditions.
It is based on 15 discharge measurements made from 1902 to 1909,
and is to be used for gage heights since 1902.
Discharge Curve.
FLOOD COMMISSION, PITTSBURGH, PA.
DISCHARGE CURVE
FOR CHEAT RIVER NEAR MORGANTOWN, W. VA.
DEC. 1910.
Gage Height in Feet
Discharge, Cubic Feet per Second
0
5000
10000
15000
20000
25000
14
13
12
11
10
9
8
7
6
5
4
3
2

Rating Table for Cheat River near Morgantown, W. Va., for 1899 to 1900.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.30	165	2.50	970	3.70	3500	4.90	7790	6.10	12610
.40	200	.60	1100	.80	3820	5.00	8180	.20	13020
.50	240	.70	1240	.90	4150	.10	8570	.30	13430
.60	280	.80	1400	4.00	4490	.20	8970	.40	13840
.70	325	.90	1570	.10	4830	.30	9370	.50	14250
.80	375	3.00	1750	.20	5180	.40	9770	.60	14670
.90	430	.10	1940	.30	5540	.50	10170	.70	15090
2.00	495	.20	2150	.40	5900	.60	10570	.80	15510
.10	570	.30	2380	.50	6270	.70	10970	.90	15930
.20	655	.40	2630	.60	6640	.80	11380	7.00	16350
.30	750	.50	2900	.70	7020	.90	11790	....	.....
.40	855	.60	3190	.80	7400	6.00	12200	....	.....

Note: The above table is not applicable for ice or obstructed-channel conditions. It is based on four discharge measurements made 1899–1901 and is fairly well defined. Above gage height 3.0 feet the rating curve is based on the form of the rating referred to the chain gage at Ice's Ferry bridge and should be accurate. This table applies to original gage located about 100 feet above the present Ice's Ferry bridge.

Rating Table for Cheat River near Morgantown, W. Va., for 1902 to 1909.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.50	110	3.00	815	4.50	3090	6.00	7010	7.50	11700
.60	135	.10	905	.60	3310	.10	7310	.60	12030
.70	160	.20	1005	.70	3530	.20	7610	.70	12360
.80	190	.30	1110	.80	3760	.30	7910	.80	12690
.90	220	.40	1220	.90	4000	.40	8210	.90	13030
2.00	255	.50	1340	5.00	4250	.50	8520	8.00	13370
.10	290	.60	1470	.10	4500	.60	8830	9.00	16830
.20	330	.70	1610	.20	4760	.70	9140	10.00	20430
.30	375	.80	1760	.30	5030	.80	9450	11.00	24180
.40	420	.90	1920	.40	5300	.90	9760	12.00	27980
.50	470	4.00	2090	.50	5580	7.00	10080	13.00	31880
.60	525	.10	2280	.60	5860	.10	10400	....	.....
.70	590	.20	2470	.70	6140	.20	10720	....	.....
.80	660	.30	2670	.80	6430	.30	11040	....	.....
.90	735	.40	2880	.90	6720	.40	11370	....	.....

Note: The above table is not applicable for ice or obstructed-channel conditions. It is based on fifteen discharge measurements made during 1902 to 1909 and is well defined between gage heights 1.6 feet and 8.0 feet.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1899.

Day	July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft*
1	....	....	3.00	1750	2.20	655	2.00	495	3.70	3500	2.90	1570
2	....	....	2.80	1400	2.00	495	2.00	495	4.00	4490	2.80	1400
3	....	....	2.70	1240	2.30	750	1.90	430	3.80	3820	2.70	1240
4	....	....	2.50	970	2.20	655	1.90	430	3.50	2900	2.70	1240
5	....	....	3.40	2630	2.20	655	1.90	430	3.30	2380	2.60	1100
6	....	....	3.30	2380	2.20	655	1.90	430	3.10	1940	2.60	1100
7	....	....	3.00	1750	2.10	570	1.80	375	2.10	570	2.50	970
8	2.60	1100	2.80	1400	2.00	495	1.80	375	2.10	570	2.50	970
9	3.00	1750	2.70	1240	2.00	495	1.80	375	2.80	1400	2.50	970
10	2.80	1400	2.60	1100	2.20	655	1.70	325	2.70	1240	2.50	970
11	2.70	1240	2.50	970	4.10	4830	1.70	325	2.60	1100	2.70	1240
12	2.50	970	2.40	855	3.80	3820	1.70	325	2.90	1570	5.50	10200
13	2.40	855	2.30	750	3.50	2900	1.70	325	2.70	1240	6.40	13800
14	2.50	970	2.20	655	3.20	2150	1.70	325	2.60	1100	4.80	7400
15	2.80	1400	2.20	655	3.00	1750	1.70	325	2.60	1100	4.20	5180
16	2.80	1400	2.30	750	2.80	1400	1.70	325	2.50	970	3.80	3820
17	3.50	2900	2.40	855	2.70	1240	1.80	375	2.40	855	3.40	2630
18	3.40	2630	2.30	750	2.30	750	1.80	375	2.40	855	3.20	2150
19	3.00	1750	2.20	655	2.20	655	1.70	325	2.50	970	3.00	1750
20	2.80	1400	2.10	570	2.00	495	1.70	325	3.40	2630	4.80	7400
21	2.40	855	2.00	495	1.90	430	1.60	280	3.40	2630	4.40	5900
22	2.40	855	2.00	495	1.90	430	1.60	280	3.20	2150	4.10	4830
23	2.40	855	1.90	430	2.30	750	1.60	280	3.00	1750	3.90	4150
24	2.30	750	1.90	430	2.20	655	1.60	280	3.00	1750	5.20	8970
25	2.50	970	1.80	375	2.20	655	1.60	280	3.90	4150	4.40	5900
26	2.70	1240	1.80	375	2.10	570	1.70	325	3.70	3500	3.60	3190
27	2.80	1400	1.80	375	2.30	750	1.70	325	3.50	2900	3.20	2150
28	2.60	1100	2.50	970	2.40	855	1.70	325	3.30	2380	2.90	1570
29	2.50	970	2.40	855	2.30	750	1.70	325	3.10	1940	2.70	1240
30	3.50	2900	2.30	750	2.20	655	1.70	325	3.10	1940	2.60	1100
31	3.60	3190	2.30	750	....	...	1.70	325	....	....	a2.50	970

a. Estimated. The temperature was low December 25 to 31, but the discharge was probably not materially affected by ice conditions.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1900.

Day	July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.20	2150	3.20	2150	2.30	750	2.10	570	1.60	280	....	6270
2	2.80	1400	3.10	1940	2.10	570	2.00	495	1.60	280	4.00	4490
3	2.70	1240	2.90	1570	2.00	495	1.90	430	1.70	325	4.00	4490
4	2.60	1100	2.70	1240	1.90	430	1.80	375	1.70	325	4.30	5540
5	2.60	1100	2.60	1100	1.60	280	1.70	325	1.60	280	7.00	16400
6	2.40	855	2.40	855	1.50	240	1.60	280	2.00	495	7.00	16400
7	2.30	750	2.40	855	1.40	200	1.50	240	2.30	750	6.00	12200
8	3.00	1750	2.30	750	1.40	200	1.60	280	2.50	970	5.00	8180
9	2.90	1570	2.00	495	1.40	200	1.70	325	2.40	855	4.40	5900
10	2.90	1570	2.00	495	1.40	200	1.70	325	2.20	655	4.70	7020
11	2.80	1400	2.00	495	1.40	200	1.70	325	2.00	495	3.40	2630
12	2.70	1240	1.80	375	1.40	200	1.70	325	1.90	430	3.40	2630
13	2.60	1100	1.70	325	1.30	165	1.60	280	1.90	430	3.20	2150
14	2.50	970	1.70	325	1.30	165	1.50	240	1.90	430	3.00	1750
15	2.60	1100	1.70	325	1.30	165	1.50	240	2.00	495	3.00	1750
16	2.60	1100	1.60	280	1.40	200	1.40	200	2.20	655	3.00	1750
17	2.80	1400	1.60	280	1.40	200	1.40	200	2.20	655	2.90	1570
18	2.90	1570	1.50	240	1.40	200	1.40	200	2.10	570	2.80	1400

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1900.—(Continued.)

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
19	2.90	1570	1.50	240	1.40	200	1.50	240	2.20	655	2.80	1400
20	3.00	1750	1.60	280	1.40	200	1.40	200	3.00	1750	2.70	1240
21	3.00	1750	2.00	495	1.30	165	1.30	165	3.30	2380	2.70	1240
22	3.00	1750	1.90	430	1.50	240	1.30	165	3.50	2900	2.60	1100
23	2.90	1570	1.80	375	1.50	240	1.30	165	3.80	3820	3.00	1750
24	3.50	2900	1.80	375	1.40	200	2.30	750	4.00	4490	3.20	2150
25	4.80	7400	1.80	375	1.40	200	2.30	750	5.00	8180	3.30	2380
26	5.10	8570	1.80	375	1.50	240	2.20	655	....	14000	3.30	2380
27	5.20	8970	1.70	325	1.30	165	2.10	570	....	20000	3.20	2150
28	4.90	7790	1.70	325	1.30	165	2.00	495	....	13800	3.10	1940
29	3.70	3500	2.00	495	1.40	200	1.80	375	....	9770	3.10	1940
30	3.40	2630	2.30	750	1.40	200	1.70	325	....	8180	3.50	2900
31	3.20	2150	2.30	750	....	...	1.60	280	....	....	3.50	2900

Discharges November 25 to December 1 and December 30 and 31, estimated by a hydrograph comparison with Youghiogheny River at Friendsville, Md.

The discharge was probably unaffected by ice conditions during December.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1902.

Day	August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	.....	.....	2.05	272	3.15	955	2.85	698	5.00	4250
2	.....	.....	2.05	272	5.15	4630	2.55	498	4.85	3880
3	.....	.....	2.05	272	4.00	2090	2.55	498	6.40	8210
4	.....	.....	2.15	310	3.75	1680	2.55	498	6.65	8980
5	.....	.....	2.00	255	3.75	1680	2.40	420	5.70	6140
6	.....	.....	2.65	558	3.80	1760	2.25	352	4.95	4120
7	.....	.....	2.35	398	3.40	1220	2.50	470	4.50	3090
8	.....	.....	2.20	330	3.20	1000	2.55	498	4.45	2980
9	.....	.....	2.05	272	2.95	775	2.75	625	4.30	2670
10	.....	.....	2.05	272	2.70	590	2.60	525	3.90	1920
11	.....	.....	2.05	272	2.55	498	2.55	498	5.95	6860
12	.....	.....	1.95	238	5.80	6430	2.55	498	11.05	24400
13	.....	.....	1.95	238	5.30	5030	2.55	498	10.65	22800
14	.....	.....	1.85	205	4.75	3640	2.60	525	9.10	17200
15	.....	.....	1.85	205	4.10	2280	2.55	498	6.85	9600
16	.....	.....	1.80	190	3.65	1540	2.55	498	10.60	22700
17	.....	.....	1.75	175	3.35	1160	2.55	498	9.35	18100
18	.....	.....	1.75	175	3.15	955	2.55	498	7.65	12200
19	.....	.....	1.85	205	3.00	815	2.35	398	6.00	7010
20	.....	.....	1.75	175	2.80	660	2.35	398	4.30	2670
21	2.15	310	1.75	175	2.80	660	2.50	470	4.75	3640
22	2.25	352	1.65	148	2.70	590	2.75	625	5.55	5720
23	2.95	775	1.65	148	2.55	498	2.70	590	5.85	6580
24	3.05	860	1.65	148	2.55	498	3.10	905	5.15	4630
25	2.65	558	1.65	148	2.55	498	4.70	3530	4.65	3420
26	2.40	420	1.80	190	2.45	445	8.15	13900	4.30	2670
27	2.25	352	2.05	272	2.55	498	6.95	9920	3.80	1760
28	2.15	310	1.95	238	3.10	905	5.70	6140	3.55	1400
29	2.05	272	2.35	398	2.95	775	4.90	4000	3.70	1610
30	2.05	272	2.40	420	2.95	775	4.40	2880	5.10	4500
31	2.05	272	....	...	2.85	698	....	....	4.90	4000

Discharge unaffected by ice conditions during December.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1903.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.30	2670	6.50	8520	10.70	23000	4.05	2180	3.50	1340	3.60	1470	6.00	7010	2.60	525	2.60	525	1.75	175	1.85	205	2.20	330
2	4.10	2780	6.75	9300	7.10	10400	4.15	2380	3.40	1220	3.30	1110	5.60	5860	3.15	955	2.55	498	1.75	175	1.85	205	2.20	330
3	10.25	21400	7.50	11700	5.95	6860	4.15	2380	3.35	1160	3.35	1160	4.45	2980	3.05	860	2.50	470	1.75	175	1.85	205	2.25	352
4	9.05	17000	9.35	18100	5.25	4900	4.40	2880	3.65	1540	3.05	860	4.00	2090	2.85	698	2.35	398	1.75	175	1.85	205	2.25	352
5	6.95	9920	8.95	16700	4.90	4000	5.70	6140	3.60	1470	2.85	698	4.20	2470	2.70	590	2.15	310	1.90	220	1.90	220	2.15	310
6	5.85	6580	6.60	8830	4.85	3880	4.95	4120	3.40	1220	2.85	698	4.95	4120	2.45	445	2.15	310	2.20	330	2.10	290	2.15	310
7	5.15	4630	5.70	6140	5.10	4500	4.80	3760	3.25	1060	3.85	1840	4.30	2670	2.65	558	2.05	272	2.20	330	2.25	352	2.15	310
8	4.70	3530	5.15	4630	7.25	10900	6.90	9760	3.10	905	6.00	7010	4.05	2180	2.45	445	2.05	272	2.05	272	2.50	470	2.10	290
9	3.95	2000	4.95	4120	8.40	14700	8.50	15100	3.05	860	5.00	4250	3.55	1400	2.45	445	2.05	272	3.40	1220	2.40	420	2.05	272
10	3.65	1540	4.45	2980	6.90	9760	6.70	9140	2.90	735	4.30	2670	3.30	1110	2.35	398	2.15	310	3.45	1280	2.25	352	2.10	290
11	3.75	1200	4.30	2670	6.05	7160	5.80	6430	2.85	698	3.95	2000	3.80	1760	2.30	375	2.15	310	3.00	815	2.20	330	2.15	310
12	6.20	1000	5.40	5300	5.65	6000	5.40	5300	2.85	698	5.15	4630	4.30	2670	2.25	352	2.10	290	2.60	525	2.15	310	2.00	255
13	5.25	700	6.10	7310	5.30	5030	5.30	5030	2.70	590	7.05	10200	5.10	4500	2.25	352	2.00	255	2.45	445	2.10	290	2.15	310
14	5.70	500	5.30	5030	4.95	4120	5.10	4500	2.65	558	7.15	10600	5.65	6000	2.10	290	1.95	238	2.60	525	2.05	272	2.60	250
15	5.95	400	6.00	7010	4.40	2880	4.95	4120	2.60	525	7.35	11200	4.75	3640	2.10	290	1.85	205	2.45	445	2.05	272	2.60	250
16	4.45	500	11.25	25100	4.25	2570	5.85	6580	2.80	660	6.20	7610	4.05	2180	2.05	272	1.85	205	2.35	398	2.05	272	2.75	200
17	4.20	700	8.40	14700	4.15	2380	5.85	6580	2.70	590	5.10	4500	3.60	1470	2.05	272	1.85	205	2.25	352	2.55	498	2.55	200
18	3.90	700	6.45	8360	3.95	2000	5.85	6580	2.60	525	4.45	2980	3.60	1470	2.05	272	1.85	205	2.25	352	5.60	5860	2.55	200
19	3.55	500	5.20	4760	3.75	1680	5.30	5030	2.55	498	4.05	2180	3.55	1400	2.15	310	2.35	398	2.40	420	4.50	3090	2.35	250
20	3.35	700	5.10	4500	3.60	1470	4.75	3640	2.45	445	3.85	1840	4.40	2880	2.20	330	2.90	735	2.70	590	3.60	1470	2.45	445
21	3.75	800	4.50	3090	4.70	3530	4.40	2880	2.40	420	5.20	4760	4.65	3420	2.15	310	2.40	420	2.55	498	3.10	905	4.35	2780
22	4.15	700	4.35	2780	5.55	5720	4.25	2570	2.30	375	4.90	4000	3.80	1760	2.85	698	2.20	330	2.45	445	2.90	735	4.25	2570
23	4.00	700	3.95	2000	8.10	13700	4.00	2090	2.65	558	5.00	4250	3.40	1220	2.50	470	2.05	272	2.35	398	2.85	698	3.80	1760
24	3.75	600	4.15	2380	9.65	19200	3.80	1760	3.85	1840	5.65	6000	3.10	905	2.30	375	2.00	255	2.25	352	2.75	625	3.35	1160
25	3.65	700	4.20	2470	6.75	9300	3.90	1920	4.60	3310	4.75	3640	2.85	698	2.10	290	1.95	238	2.15	310	2.60	525	4.80	3760
26	3.50	800	4.05	2180	5.70	6140	3.90	1920	5.65	6000	4.05	2180	2.65	558	2.05	272	1.85	205	2.00	255	2.60	525	5.70	6140
27	3.55	1000	4.30	2670	4.95	4120	4.40	2880	6.65	8980	3.65	1540	2.55	498	2.05	272	1.85	205	2.05	272	2.40	420	4.40	2880
28	6.40	8210	11.45	25900	4.55	3200	4.15	2380	5.40	5300	4.10	2280	2.35	398	2.10	290	1.85	205	2.05	272	2.40	420	3.85	1840
29	8.65	15600	....	.....	4.15	2380	3.90	1920	4.65	3420	8.85	16300	2.45	445	2.10	290	1.85	205	2.05	272	2.25	352	3.50	1340
30	8.90	16500	....	.....	4.05	2180	3.65	1540	4.20	2470	7.70	12400	2.40	420	2.10	290	1.75	175	1.95	238	2.25	352	3.50	1340
31	8.30	14400	....	.....	4.05	2180	....	....	3.95	2000	....	.....	2.35	398	2.60	525	....	...	1.95	238	....	...	3.20	1000

Discharge affected by ice conditions from about Jan. 11 to 27 and about Dec. 14 to 19, as determined by temperature records. The temperature was very low for a few days about Feb. 18 and 19, but discharge was probably not greatly affected by ice conditions owing to flood which preceded this period.

Discharges January 1 to 27 and Deember 14 to 19, estimated on the basis of climatological reports on temperature and precipitation.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1904.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.30	1110	3.60	1470	6.55	8680	6.60	8830	6.25	7760	3.40	1220
2	3.25	1060	3.00	815	6.80	9450	6.70	9140	5.85	6580	3.45	1280
3	8.75	4000	3.25	1060	7.20	10700	5.95	6860	4.95	4120	3.50	1340
4	11.15	1800	3.15	955	8.35	14600	5.10	4500	5.00	4250	3.90	1920
5	11.15	1400	3.00	815	6.55	8680	4.55	3200	4.55	3200	3.85	1840
6	11.15	1000	3.00	815	5.50	5580	4.30	2670	4.20	2470	4.80	3760
7	11.15	900	4.90	4000	6.10	7310	4.15	2238	3.95	2000	4.30	2670
8	11.15	800	8.65	15600	7.45	11500	4.05	2180	3.75	1680	4.10	2280
9	11.15	800	6.45	8360	6.70	9140	4.05	2180	3.55	1400	3.85	1848
10	11.15	800	5.35	5160	5.70	6140	4.15	2380	3.75	1680	3.70	1610
11	11.15	800	4.65	3420	5.15	4630	4.00	2090	3.75	1680	3.50	1340
12	11.15	800	4.00	2090	5.05	4380	3.85	1840	3.45	1280	3.30	1110
13	11.15	800	3.60	1470	4.90	4000	3.80	1760	3.30	1110	3.10	905
14	11.15	800	3.65	1540	4.55	3200	3.85	1840	3.25	1060	2.90	735
15	11.15	800	3.80	1760	5.15	4630	3.70	1610	3.40	1220	2.85	698
16	11.15	800	3.40	1220	4.95	4120	3.95	2000	3.70	1610	2.85	698
17	11.15	800	2.95	775	4.40	2880	5.05	4380	3.65	1540	2.75	625
18	11.15	900	3.15	955	4.35	2780	4.65	3420	3.70	1610	2.90	735
19	11.15	1200	3.00	815	4.45	2980	4.25	2570	7.20	10700	2.95	775
20	11.15	4000	3.15	955	4.45	2980	4.00	2090	6.60	8830	2.70	590
21	11.15	9600	3.65	1540	5.10	4500	3.80	1760	6.70	9140	3.25	1060
22	21.15	15000	5.70	6140	5.65	6000	3.60	1470	6.55	8680	4.30	2670
23	10.95	21000	5.45	5440	8.15	13900	3.45	1280	6.20	7610	4.75	3640
24	7.50	11700	6.05	7160	7.85	12900	3.35	1160	4.90	4000	3.45	1280
25	5.95	6860	5.40	5300	6.40	8210	3.55	1400	4.45	2980	3.30	1110
26	5.05	4380	4.65	3420	5.85	6580	4.70	3530	4.10	2280	2.95	775
27	4.40	2880	4.20	2470	6.00	7010	6.75	9300	4.05	2180	2.85	698
28	3.80	1760	3.95	2000	5.30	5030	7.40	11400	4.15	2380	2.85	698
29	3.75	1680	5.15	4630	4.65	3420	6.50	8520	3.90	1920	3.05	860
30	3.65	1540	....	....	4.30	2670	6.05	7160	3.70	1610	3.80	1760
31	3.60	1470	....	....	4.35	2780	....	....	3.55	1400	....	....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.60	1470	2.15	310	1.80	190	1.60	135	2.00	255	2.00	255
2	4.00	2090	2.25	352	1.85	205	1.85	205	2.00	255	2.05	272
3	3.65	1540	2.15	310	1.85	205	1.90	220	1.90	220	2.20	330
4	3.35	1160	2.35	398	1.85	205	1.90	220	1.90	220	2.10	290
5	3.00	815	2.55	498	1.85	205	1.90	220	1.90	220	2.10	290
6	3.00	815	2.35	398	1.80	190	1.85	205	1.90	220	2.60	525
7	3.65	1540	2.25	352	1.75	175	1.85	205	1.82	196	2.50	470
8	3.50	1340	2.30	375	1.75	175	1.90	220	1.80	190	2.50	470
9	3.40	1220	2.15	310	1.75	175	1.80	190	1.80	190	2.50	470
10	3.30	1110	2.05	272	1.75	175	1.90	220	1.80	190	2.40	420
11	3.55	1400	2.05	272	1.75	175	1.95	238	1.80	190	2.35	398
12	3.50	1340	2.00	255	1.75	175	2.00	255	1.80	190	2.20	330
13	3.35	1160	2.05	272	1.75	175	2.05	272	1.80	190	2.15	310
14	3.05	860	2.05	272	1.85	205	2.75	625	1.80	190	2.05	272
15	2.80	660	2.05	272	1.85	205	2.30	375	1.90	220	2.15	310
16	2.70	590	1.95	238	2.08	283	2.20	330	1.95	238	2.15	310
17	2.55	498	1.95	238	1.95	238	2.15	310	1.88	214	2.10	290
18	2.55	498	1.95	238	2.02	262	2.05	272	1.90	220	2.20	330
19	2.35	398	2.00	255	1.92	227	2.00	255	1.90	220	2.20	330
20	2.30	375	1.95	238	1.85	205	2.00	255	1.90	220	2.20	330
21	2.75	625	2.35	398	2.20	330	1.90	220	2.05	272	2.15	310
22	3.00	815	2.10	290	2.10	290	2.00	255	2.10	290	2.10	290
23	3.25	1060	2.40	420	1.90	220	2.00	255	2.35	398	2.00	255
24	2.80	660	2.55	498	1.85	205	2.10	290	2.45	445	2.60	525
25	2.60	525	2.55	498	1.80	190	2.10	290	2.40	420	8.20	14000
26	2.45	445	2.40	420	1.75	175	2.00	255	2.40	420	7.20	10700
27	2.55	498	2.20	330	1.75	175	2.00	255	2.35	398	7.20	10700
28	2.45	445	2.05	272	1.62	140	2.10	290	2.05	272	6.80	9450
29	2.50	470	1.95	238	1.60	135	2.00	255	2.10	290	5.40	5300
30	2.35	398	1.85	205	1.60	135	2.00	255	2.00	255	4.20	2470
31	2.20	330	2.35	205	....	...	2.00	255	....	...	3.85	1840

Ice gorge from January 3 to 23. No ice during December on basis of comparison with chain gage heights.

Discharge estimated for ice period, January 3 to 23, on the basis of climatological reports and a thorough study of run-off conditions during the period.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1905.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.80	1760	2.95	450	5.35	1500	4.10	2280	4.40	2880	5.90	6720	3.70	1610	4.05	2180	2.70	590	2.00	255	3.55	1400	5.20	4760
2	3.60	1470	2.85	450	4.55	1500	4.00	2090	4.05	2180	5.25	4900	4.15	2380	3.80	1760	2.65	558	2.00	255	3.35	1160	4.70	3530
3	3.60	1470	2.90	450	4.10	1500	3.85	1840	3.85	1840	4.40	2880	3.80	1760	3.45	1280	2.50	470	2.00	255	3.15	955	8.25	14200
4	3.65	1540	2.85	450	3.75	1680	3.80	1760	3.70	1610	3.75	1680	3.65	1540	3.05	860	2.50	470	2.10	290	3.10	905	8.00	13400
5	3.45	1280	2.90	450	3.70	1610	3.80	1760	3.80	1760	3.55	1400	4.75	3640	2.90	735	2.45	445	2.05	272	3.00	815	6.15	7460
6	3.40	1220	2.90	500	4.70	3530	4.20	2470	4.35	2780	3.40	1220	4.15	2380	3.40	1220	2.40	420	2.10	290	3.05	860	5.10	4500
7	3.45	1280	3.10	700	5.55	5720	4.90	4000	3.95	2000	3.50	1340	3.80	1760	3.20	1000	2.40	420	2.10	290	3.40	1220	4.55	3200
8	3.35	1160	3.40	1000	8.20	14000	5.05	4380	3.80	1760	3.65	1540	4.05	1760	3.35	1160	2.35	398	2.10	290	3.60	1470	4.20	2470
9	3.20	1000	3.85	1200	11.25	25100	4.85	3880	3.80	1760	3.45	1280	4.05	2180	3.05	860	2.30	375	2.10	290	3.50	1340	4.00	2090
10	3.20	1000	5.95	4500	12.65	30400	4.80	3760	3.55	1400	3.30	1110	3.70	1610	3.15	955	2.30	375	2.00	255	3.45	1280	3.90	1920
11	3.30	1110	4.80	2500	8.75	16000	5.80	6430	3.45	1280	3.15	955	3.65	1540	3.15	955	2.85	698	2.00	255	3.35	1160	3.60	1470
12	6.45	8360	4.35	1500	7.05	10200	5.75	6280	7.30	11000	3.65	1540	3.60	1470	3.15	955	4.15	2380	2.30	375	3.10	905	3.55	1400
13	9.85	19900	7.40	2500	6.20	7610	4.75	3640	7.45	11500	4.55	3200	3.75	1680	3.00	815	4.10	2280	3.40	1220	3.00	815	3.45	1280
14	7.05	10200	6.25	1500	5.80	6430	4.60	3310	5.90	6720	4.25	2570	4.45	2980	3.30	1110	3.60	1470	3.20	1000	3.00	815	3.40	1220
15	5.45	5440	8.50	1000	5.40	5300	4.40	2880	8.50	15100	3.60	1470	3.85	1840	5.20	4760	3.05	860	2.90	735	2.90	735	3.30	1110
16	4.85	3880	8.30	700	5.20	4760	4.20	2470	6.75	9300	3.25	1060	3.65	1540	5.60	5860	2.90	735	2.80	660	3.00	815	3.20	1000
17	3.95	2000	8.35	600	5.75	6280	4.05	2180	6.20	7610	3.00	815	3.45	1280	5.45	5440	2.70	590	2.55	498	3.40	1220	3.15	955
18	3.85	1840	7.65	500	6.05	7160	3.80	1760	5.25	4900	3.00	815	3.10	905	4.30	2670	2.65	558	2.40	420	3.55	1400	3.10	905
19	3.80	1760	6.70	500	6.85	9600	3.70	1610	4.80	3760	3.00	815	2.90	735	4.00	2090	2.50	470	2.45	445	3.40	1220	3.20	1000
20	3.80	1760	6.55	600	8.20	14000	3.70	1610	4.45	2980	3.00	815	3.80	1760	3.50	1340	2.45	445	6.60	8830	3.35	1160	3.20	1000
21	3.80	1760	6.55	700	10.85	23000	4.60	3310	4.10	2280	3.05	860	4.30	2670	3.45	1280	2.40	420	6.00	7010	3.05	860	5.10	4500
22	3.60	1470	7.00	700	9.35	18100	5.65	6000	3.85	1840	5.30	5030	3.70	1610	3.05	860	2.30	375	5.20	4760	2.80	660	5.85	6580
23	3.50	1340	8.00	800	7.25	10900	5.35	5160	3.55	1400	5.25	4900	3.80	1760	2.90	735	2.30	375	4.65	3420	2.65	558	5.95	6860
24	3.40	1220	7.90	800	6.10	7310	4.65	3420	3.50	1340	4.85	3880	5.50	5580	2.75	625	2.25	352	3.25	1060	2.45	445	6.05	7160
25	3.20	1000	7.50	800	6.65	8980	4.35	2780	3.30	1110	5.90	6720	4.35	2780	4.35	2780	2.20	330	3.10	905	3.30	1110	4.95	4120
26	2.80	660	7.85	1800	6.55	8680	4.05	2180	3.20	1000	5.00	4250	3.70	1610	5.25	4900	2.10	290	4.15	2380	3.30	1110	4.15	2380
27	2.95	600	7.25	1500	6.05	7160	4.35	2780	3.10	905	6.90	9760	3.55	1400	4.25	2570	2.10	290	5.25	4900	3.30	1110	4.20	2470
28	2.90	550	6.30	1500	5.60	5860	5.90	6720	3.00	815	5.45	5440	3.25	1060	3.75	1680	2.10	290	4.55	3200	3.30	1110	4.00	2090
29	2.95	500	....	....	5.10	4500	5.40	5300	3.00	815	4.50	3090	3.20	1000	3.55	1400	2.00	255	3.90	1920	5.10	4500	4.15	2380
30	3.00	500	....	....	4.85	3880	4.95	4120	2.95	775	3.90	1920	5.15	4630	2.90	735	2.00	255	3.80	1760	7.30	11000	4.25	2570
31	3.15	450	....	....	4.65	3420	....	....	3.20	1000	....	....	4.60	3310	2.90	735	....	....	3.65	1540	....	....	4.15	2380

High gage heights Feb. 12 to about Mar. 3 caused by backwater from ice gorge.
Ice conditions probably prevailed from about Jan. 27 to Mar. 3. No ice during December on the basis of comparison with chain gage heights.
Discharge January 27 to Mar. 3 estimated on basis of climatological reports.
Daily gage heights and discharges for November and December, 1908, will be found on page 280.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1909.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.44	1270	3.20	1000	5.00	4250	4.50	3090	5.44	5410	3.14	945
2	2.98	799	3.10	905	4.73	3000	4.39	2860	6.36	8090	5.08	4450
3	2.82	675	3.20	1000	5.36	5190	5.10	4500	6.57	8740	5.18	4710
4	2.68	577	3.35	1160	6.68	9080	5.44	5410	5.38	5250	4.49	3070
5	2.70	590	3.62	1500	5.63	5940	5.71	6170	5.25	4900	5.66	6030
6	2.78	646	4.95	4120	5.08	4450	6.08	7250	4.84	3860	7.21	10800
7	3.65	1540	5.25	4900	4.90	4000	5.97	6920	4.43	2940	5.82	6490
8	3.56	1420	4.80	3760	5.90	6720	5.38	5250	4.14	2360	5.14	4600
9	3.08	887	4.30	2670	5.95	6860	4.53	3160	3.98	2060	7.02	10100
10	3.18	985	5.96	6890	6.92	9820	4.47	3030	3.89	1900	6.20	7610
11	3.10	905	6.90	9760	6.66	9020	4.20	2470	3.68	1580	7.68	12300
12	3.13	935	5.45	5440	6.54	5690	4.12	2320	4.11	2300	6.57	8740
13	3.45	1280	5.00	4250	4.98	4200	4.20	2470	3.75	1680	5.29	5000
14	3.47	1300	5.50	5580	4.80	3760	8.28	14300	3.56	1420	5.15	4630
15	8.75	16000	5.50	5580	5.07	4420	8.04	13500	3.40	1220	5.35	5160
16	7.40	11400	7.20	10700	4.56	3220	6.22	7670	3.28	1090	5.11	4530
17	5.75	6280	7.12	10500	4.30	2670	5.33	5110	3.14	945	3.80	3760
18	4.80	3760	5.94	6840	4.14	2360	4.78	3710	3.03	842	6.94	9890
19	4.05	2180	5.16	4660	3.94	1990	4.40	2880	2.99	807	6.13	7400
20	4.00	2090	5.20	4760	4.12	2330	4.36	2800	2.89	728	5.07	4420
21	4.13	2340	5.73	6230	4.18	2430	7.09	10400	2.86	705	4.38	2840
22	4.37	2820	5.40	5300	4.02	2130	9.06	17000	3.06	869	4.00	2090
23	4.58	3270	5.47	5500	3.83	1810	7.84	12800	4.19	2450	3.86	1860
24	5.80	6430	7.95	13200	3.68	1580	7.50	11700	3.60	1470	3.72	1640
25	5.40	5300	7.58	12000	3.86	1860	6.32	7970	3.40	1220	3.45	1280
26	4.80	3760	6.30	7910	4.58	3270	5.71	6170	3.24	1050	3.29	1100
27	4.40	2880	5.64	5970	5.27	4950	5.46	5470	3.38	1200	3.16	965
28	3.85	1840	5.34	5140	5.18	4710	5.18	4710	3.98	2060	3.49	1330
29	3.60	1470	....	....	5.48	5520	5.00	4250	4.00	2090	4.19	2450
30	3.80	1760	....	....	5.07	4420	4.90	4000	3.56	1420	3.95	2000
31	3.45	1280	....	....	4.78	3710	....	....	3.34	1150	....	....

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.56	1420	5.30	5030	3.12	925	2.67	570	3.37	1190	3.16	965
2	3.50	1340	4.24	2550	2.86	705	2.60	525	3.40	1220	3.09	896
3	3.38	1200	3.75	1680	2.75	625	2.56	503	3.21	1020	3.00	815
4	3.06	869	3.34	1150	2.80	660	2.45	445	3.14	945	2.91	743
5	2.87	712	3.11	915	2.92	751	2.43	435	3.11	915	2.87	712
6	2.75	625	2.97	791	2.87	712	2.36	402	3.01	824	2.85	698
7	2.64	551	2.87	712	2.91	743	2.29	370	3.09	896	2.80	660
8	2.54	492	2.80	660	2.76	632	2.26	357	2.86	705	3.27	1080
9	2.54	492	2.70	590	2.68	577	2.24	348	3.03	842	3.04	851
10	2.52	481	2.61	532	2.65	558	2.21	334	3.05	860	2.87	650
11	2.43	435	2.54	492	6.00	7010	2.24	348	4.82	3810	2.82	600
12	2.34	393	2.50	470	4.45	2980	2.82	675	4.32	2710	2.75	550
13	2.41	425	2.42	430	3.70	1610	4.66	3440	3.98	2060	2.94	700
14	2.49	465	2.32	384	3.25	1060	3.72	1640	3.70	1610	5.59	5830
15	2.45	445	2.52	481	3.06	869	3.32	1130	3.53	1380	5.46	5470
16	2.68	577	3.98	2060	5.43	5380	3.42	1240	3.36	1180	4.57	3240
17	2.50	470	5.35	5160	5.00	4250	3.53	1380	3.24	1050	3.98	2060
18	2.39	416	4.57	3240	4.06	2200	3.38	1200	3.19	995	3.95	1500
19	2.36	402	3.95	2000	3.45	1280	3.36	1180	3.20	1000	3.74	1200
20	2.31	380	3.61	1480	3.11	915	4.09	2260	3.11	915	3.65	1000
21	2.28	366	4.16	2390	2.92	751	3.92	1950	3.01	824	3.23	800
22	2.26	357	3.37	1190	2.82	675	3.71	1620	3.01	824	2.91	500
23	2.34	393	3.19	995	2.73	611	4.00	2090	3.04	851	2.65	450
24	2.41	425	2.99	807	2.87	712	9.16	17400	3.11	915	....	450
25	3.41	1230	2.83	682	4.16	2390	6.59	8800	a	1140	2.77	450
26	3.11	915	2.68	577	3.64	1530	5.37	5220	3.53	1380	2.65	400
27	2.77	639	2.63	544	3.21	1020	4.71	3550	3.37	1190	2.87	450
28	2.63	544	2.54	492	3.07	878	4.24	2550	3.19	995	2.83	400
29	2.58	514	2.68	577	2.87	712	3.88	1890	3.11	915	2.68	350
30	2.63	544	3.70	1610	2.77	639	3.72	1640	3.06	869	2.61	300
31	8.53	15200	3.51	1350	....	...	3.49	1330	....	...	2.45	250

Discharge probably unaffected by ice conditions January to March.
Discharge about December 10 to 13 and 18 to 31, affected by ice conditions.
Discharge December 10 to 13 and 18 to 31, estimated on the basis of climatological data.
a. Interpolated.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.53	486	3.77	1715	6.37	8120	3.00	815	3.72	1640	4.04	2166	3.26	1068	2.64	547	2.36	402	2.44	440	2.49	465	3.68	1582
2	2.88	720	3.54	1392	6.09	7280	3.00	815	3.51	1353	5.06	4400	3.09	896	2.63	542	2.44	440	2.33	388	2.42	430	3.28	1089
3	10.10	20805	3.68	1582	5.48	5524	3.00	815	3.42	1244	5.18	4708	3.04	851	2.48	460	2.52	481	2.24	348	2.36	402	3.17	975
4	8.08	13650	3.83	1808	4.96	4150	2.99	807	3.34	1154	5.05	4375	3.85	1840	2.42	430	3.42	1264	2.20	330	2.33	389	3.12	915
5	5.88	6662	3.90	1920	4.62	3354	3.17	975	3.12	915	4.65	3420	4.35	2775	2.40	420	3.01	824	2.18	322	2.43	435	3.01	824
6	5.74	6256	3.77	1715	4.40	2880	3.18	985	3.12	915	6.26	7790	4.32	2712	2.32	384	3.02	833	2.16	314	2.41	425	2.78	646
7	7.56	11898	3.36	1176	4.34	2751	3.15	955	3.06	869	5.72	6198	3.84	1808	2.52	481	3.45	1280	2.11	294	2.36	402	3.14	945
8	6.34	8030	3.58	1444	4.28	2630	3.11	915	3.09	896	4.92	4050	3.97	2039	2.47	455	3.09	896	2.08	283	2.32	384	2.90	735
9	5.30	5030	3.43	1256	3.92	1954	3.11	915	3.22	1026	4.49	3069	3.93	1971	2.36	402	2.83	682	2.15	310	2.28	366	2.60	525
10	4.51	3112	3.79	1745	3.74	1670	3.01	824	3.28	1089	4.65	3420	3.63	1512	2.32	384	2.74	618	2.03	266	2.27	362	2.70	590
11	3.96	2022	4.22	2510	3.54	1392	2.96	783	3.40	1220	5.14	4604	3.54	1392	2.30	375	2.61	530	2.00	255	2.22	339	2.68	569
12	3.86	1856	3.84	1824	3.45	1280	2.88	720	4.31	2691	5.32	5084	3.40	1220	2.28	366	2.58	514	2.22	339	2.24	347	....	....
13	3.76	1700	3.49	1328	3.42	1244	2.84	690	5.14	4604	5.38	5246	3.38	1198	2.27	361	2.50	470	2.30	375	2.26	356	....	....
14	5.48	5524	3.32	1132	3.34	1154	2.81	667	4.50	3090	5.00	4250	3.93	1971	2.21	335	2.61	530	2.22	339	2.26	356	....	....
15	5.16	4656	3.16	965	3.20	1005	3.02	833	4.04	2166	4.68	3486	3.85	1840	2.16	314	2.62	535	2.16	314	2.26	356	....	....
16	4.92	4050	3.67	1568	3.20	1005	2.96	783	3.82	1792	4.78	3714	3.60	1470	2.21	335	2.63	541	2.10	290	2.24	347	....	....
17	4.06	2204	6.84	9574	3.12	925	3.00	815	3.62	1498	8.92	16550	3.40	1220	2.22	339	2.62	535	2.04	269	2.22	339	....	....
18	6.67	9047	6.86	9636	3.20	1005	3.15	915	3.52	1366	6.51	8551	3.26	1068	2.20	330	2.54	492	2.01	258	2.20	330	....	....
19	8.42	14823	5.84	6546	3.13	935	3.44	1268	3.46	1292	11.84	27370	3.44	1268	2.18	322	2.40	420	2.02	262	2.20	330	....	....
20	5.94	6836	5.04	4350	3.08	887	3.54	1392	3.34	1154	7.79	12657	3.24	1047	2.16	314	2.32	384	1.98	248	2.16	314	....	....
21	5.58	5804	5.01	4275	3.07	878	3.78	1730	3.34	1154	5.76	6314	3.08	887	2.16	314	2.26	357	1.99	252	2.14	306	....	....
22	6.13	7400	7.10	10400	3.26	1068	4.26	2590	3.32	1132	5.55	5720	2.96	783	2.07	279	2.23	343	2.00	255	2.15	310	....	....
23	5.36	5192	6.69	9109	3.30	1110	4.34	2775	3.24	1047	4.80	3760	2.86	705	2.04	269	2.23	343	2.03	265	2.20	330	....	....
24	4.56	3222	5.34	5138	3.22	1026	4.52	3134	3.22	1026	4.30	2670	2.72	604	2.23	343	2.22	339	2.03	265	2.24	347	....	....
25	4.26	2590	4.66	3442	3.20	1005	4.90	4000	3.46	1292	4.04	2166	2.68	569	2.17	318	2.20	330	2.06	276	2.33	389	....	....
26	3.93	1971	4.21	2490	3.22	1026	4.88	3952	4.12	2318	3.83	1808	2.62	536	2.14	306	2.14	306	2.44	440	2.84	690	....	....
27	4.54	3178	4.14	2356	3.24	1047	4.75	3645	3.87	1872	3.54	1392	2.57	507	2.16	314	2.08	283	2.34	393	3.30	1110	....	....
28	5.02	4300	5.02	4300	3.14	945	4.60	3310	3.62	1498	3.47	1304	2.52	481	2.14	306	2.07	280	2.31	379	3.16	965	....	....
29	4.56	3222	....	....	3.10	905	4.12	2318	3.44	1268	3.48	1316	2.57	507	2.08	283	2.52	481	2.32	384	4.64	3398	....	....
30	3.83	1808	....	....	3.07	878	3.94	1988	3.32	1132	3.48	1316	2.58	514	2.04	269	2.46	450	2.48	460	4.28	2630	7.50	11700
31	3.89	1903	....	....	3.04	851	....	....	3.30	1110	....	....	2.71	597	2.03	266	....	...	2.58	514	....	....	6.21	7640

Note. Frozen December 12-29.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.94	6836	6.84	9702	5.18	4709	4.73	3599	4.35	2775	3.25	1058	3.24	1047	2.24	448
2	7.08	10336	6.07	7160	4.73	3599	4.46	3006	4.61	3332	3.60	1420	3.08	887	2.18	322
3	8.17	13958	5.63	5945	4.38	2838	4.58	3266	4.40	2880	3.32	1132	2.92	751	2.20	330
4	8.00	13370	5.57	5750	4.17	2413	5.34	5138	4.14	2356	3.07	821	2.84	690	2.24	448
5	6.28	7850	5.42	5356	3.93	1971	10.48	22280	3.90	1920	2.90	735	2.74	618	2.62	536
6	5.25	4895	5.17	4660	4.34	2754	9.72	19400	3.73	1655	2.91	743	2.70	590	2.50	470
7	4.75	3645	4.48	3856	6.59	8799	7.83	12700	3.53	1379	6.44	8334	2.95	775	2.53	486
8	4.38	2838	4.64	3398	6.35	8060	6.97	9985	3.53	1379	5.90	6720	3.20	1005	2.54	492
9	4.40	2880	5.10	8575	5.39	5273	7.39	10838	3.43	1256	4.59	3508	3.10	905	2.48	460
10	4.03	2147	5.18	8891	5.94	6816	6.98	10017	3.37	1187	4.00	2090	3.40	1220	2.50	470
11	3.75	1685	4.71	7058	6.97	9986	6.00	7010	3.26	1068	3.63	1512	3.16	965	2.37	406
12	4.38	2838	4.39	2859	6.10	7310	5.42	3556	3.18	985	4.23	2530	3.11	915	2.28	366
13	12.07	32153	4.30	2670	6.04	7130	4.95	4125	3.11	915	4.10	2280	3.74	1670	a2.38	411
14	10.68	22980	4.23	2530	6.94	9881	4.78	3714	3.00	815	4.38	2838	3.24	1047	a2.48	460
15	8.75	15965	4.54	3178	5.99	7007	6.64	8954	2.97	791	4.10	2280	2.94	767	2.68	579
16	8.07	13612	4.46	3006	5.58	5804	6.47	8427	2.87	713	3.78	1730	2.74	618	3.18	985
17	6.73	9282	4.27	2610	5.01	4275	5.36	5192	2.85	698	3.32	1132	2.65	552	2.68	579
18	5.74	6282	4.13	2337	5.10	4530	5.28	4976	2.75	625	6.35	8060	2.56	503	2.46	450
19	4.87	3918	4.22	2510	5.12	4586	4.98	4200	2.75	625	7.44	11502	2.52	481	2.54	492
20	4.61	3332	4.47	3027	7.21	10753	5.36	5192	2.75	625	5.46	5468	2.48	460	2.40	420
21	4.43	2943	4.62	3354	6.34	8030	6.47	8427	2.87	713	4.62	3354	2.48	460	2.30	375
22	5.14	4607	4.33	2733	5.65	6003	6.35	8060	3.02	833	4.17	2413	2.46	450	2.22	339
23	5.88	6662	4.10	2280	5.25	4895	7.12	10464	2.89	728	4.38	2838	2.50	470	2.19	326
24	5.12	4556	4.01	2108	5.19	4734	6.47	8427	2.89	728	3.45	2985	2.52	481	2.20	330
25	4.75	3645	4.03	2144	4.62	5917	5.84	6546	2.95	775	3.41	2901	2.48	460	a2.40	420
26	5.10	4505	4.49	2969	4.40	2880	5.28	4976	2.95	775	4.94	4100	2.47	455	2.88	720
27	7.65	12195	5.18	4709	4.26	2590	4.88	3952	2.91	743	5.67	6050	2.41	425	2.76	632
28	8.42	14823	5.76	6316	4.39	2859	4.55	3210	4.46	3006	4.98	4200	2.37	406	2.92	751
29	8.04	13516	....	....	4.40	2880	4.40	2880	3.66	1554	4.24	2530	2.36	401	5.81	6459
30	15.34	41800	....	....	4.38	2838	4.36	2796	3.43	1256	3.77	1715	2.29	371	6.85	9605
31	9.15	17360	....	....	4.95	4125	....	....	3.26	1068	....	....	2.28	366	8.98	16760

a. Interpolated from Rowlesburg.

Daily Gage Heights and Discharges of Cheat River near Morgantown, W. Va., for 1908.

Day	November		December		Day	November		December	
	Gage Ht.	Discharge	Gage Ht.	Discharge		Gage Ht.	Discharge	Gage Ht.	Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*		*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	1.71	163	17	....	....	2.44	440
2	....	....	1.71	163	18	1.61	138	2.70	590
3	....	....	1.66	150	19	1.61	138	4.65	3420
4	....	....	1.66	150	20	1.61	138	4.00	2090
5	....	....	1.66	150	21	1.61	138	3.40	1220
6	....	....	1.66	150	22	1.61	138	2.78	646
7	....	....	1.66	150	23	1.74	172	2.60	525
8	....	....	1.86	208	24	1.81	193	2.57	508
9	....	....	1.86	208	25	1.81	193	2.50	470
10	....	....	1.99	252	26	1.81	193	2.32	384
11	....	....	2.00	255	27	1.76	178	2.35	398
12	....	....	2.32	384	28	1.76	178	2.40	420
13	....	....	3.05	860	29	1.71	163	2.42	430
14	....	....	2.90	735	30	1.71	163	2.40	420
15	....	....	2.65	558	31	....	....	2.35	398
16	....	....	2.35	398					

Discharge unaffected by ice conditions during December.

Estimated Monthly Discharge of Cheat River near Morgantown, W. Va.

[Drainage area, 1,380 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1899					
July 8–31	3190	750	1450	1.050	0.94
August	2630	375	940	0.681	0.79
September	4830	430	1090	0.790	0.88
October	495	280	350	0.254	0.29
November	4490	570	2010	1.460	1.63
December	13800	970	3420	2.480	2.86
1900					
July	8970	750	2440	1.770	2.04
August	2150	240	635	0.460	0.53
September	750	165	249	0.180	0.20
October	750	165	348	0.252	0.29
November	a20000	280	3310	2.400	2.68
December	16400	1100	4130	2.990	3.45
1902					
August 21–31	860	272	432	0.313	0.13
September	558	148	252	0.183	0.20
October	6430	445	1490	1.080	1.24
November	13900	352	1760	1.280	1.43
December	24400	1400	7410	5.370	6.19
1903					
January—b	21400	400	4470	3.240	3.74
February	25900	2000	7830	5.670	5.90
March	23000	1470	6450	4.670	5.38
April	15100	1540	4450	3.220	3.59
May	8980	375	1680	1.220	1.41
June	16300	698	4560	3.300	3.68
July	7010	398	2280	1.650	1.90
August	955	272	423	0.307	0.35
September	735	175	306	0.222	0.25
October	1280	175	412	0.299	0.34
November	5860	205	705	0.511	0.57
December—b	6140	200	1040	0.753	0.87
The year	25900	175	2880	2.090	27.98
1904					
January	21000	800	3330	2.410	2.78
February	15600	775	3180	2.300	2.48
March	14600	2670	6500	4.710	5.43
April	11400	1160	3830	2.780	3.10
May	10700	1060	3550	2.570	2.96
June	3760	590	1420	1.030	1.15
July	2090	330	876	0.635	0.73
August	498	205	319	0.231	0.27
September	330	135	202	0.146	0.16
October	625	135	261	0.189	0.22
November	445	190	257	0.186	0.21
December	14000	255	2030	1.470	1.70
The year	21000	135	2150	1.550	21.19

a. Estimated from hydrograph comparison of this station with Youghiogheny River at Friendsville, Md.

b. Ice conditions January 11 to 27, and December 14 to 19, 1903; discharge estimated.

Estimated Monthly Discharge of Cheat River near Morgantown, W. Va.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1905					
January	19900	450	2560	1.860	2.14
February	4500	450	1090	0.790	0.82
March	30400	1500	8910	6.460	7.45
April	6720	1610	3410	2.470	2.76
May	15100	775	3460	2.510	2.89
June	9760	815	2800	2.030	2.26
July	5580	735	2060	1.490	1.72
August	5860	625	1820	1.320	1.52
September	2380	255	608	0.441	0.49
October	8830	255	1610	1.170	1.35
November	11000	445	1470	1.070	1.19
December	14200	905	3620	2.620	3.02
The year	30400	255	2780	2.020	27.61
1908					
November	193	138	163	0.118	0.06
December	3420	150	558	0.404	0.47
1909					
January	16000	577	2860	2.070	2.39
February	13200	905	5620	4.070	4.24
March	9820	1580	4390	3.180	3.67
April	17000	2320	6310	4.570	5.10
May	8740	705	2380	1.720	1.98
June	12300	945	4740	3.430	3.83
July	15200	357	1090	0.790	0.91
August	5160	384	1360	0.986	1.14
September	7010	558	1480	1.070	1.19
October	17400	334	2160	1.570	1.81
November	3810	705	1200	0.870	0.97
December	5830	...	1130	0.819	0.94
The year	17400	...	2890	2.100	28.17
1910					
January	20805	486	5482	3.907	4.504
February	10400	965	3453	2.502	2.605
March	8120	851	1996	1.446	1.667
April	4000	667	1571	1.138	1.270
May	4604	869	1510	1.094	1.261
June	27370	1304	5429	3.934	4.389
July	2775	481	1221	0.885	1.020
August	547	266	360	0.263	0.303
September	1280	280	530	0.384	0.428
October	514	252	327	0.243	0.280
November	3398	306	598	0.433	0.483
December	a....	...	...	.....	.....
11 months	27370	252	2043	1.479	18.210
1911					
January	41800	1685	9917	7.187	8.286
February	9702	2108	4343	3.147	3.277
March	10753	1971	5363	3.881	4.474
April	22280	2796	7237	5.244	5.850
May	3332	625	1295	0.938	1.081
June	11502	735	3299	2.391	2.668
July	1670	366	684	0.496	0.572
August	16760	322	1494	1.083	1.249

a. River frozen December 12-29.

SHAVERS FORK RIVER AT PARSONS, W. VA.

This station, situated on the single-span, steel, through-truss highway bridge, 600 feet northeast of the railroad station at Parsons, Tucker Co., W. Va., and ½ mile above the mouth of the river, was established October 14, 1910, by H. P. Drake, for the Flood Commission of Pittsburgh.

A chain gage measuring 21.28 feet and 11.28 feet respectively from low-water and high-water markers to the bottom of weight is installed on the downstream side of the bridge. The elevation of the zero of the gage is 1635.25. The elevation of the downstream corner of the left abutment of the railroad bridge across Shavers Fork 100 feet above the station, is 1649.84.

Measurements are made from the downstream side of the bridge at ordinary and high stages, and by wading at low stages. The initial point for soundings is the top edge of the left abutment.

The channel is straight for about 700 feet above and 1500 feet below the station. The bed of the stream is permanent and the banks are high and not subject to overflow. The extreme range of gage heights is about 12 feet.

The gage is read daily by R. W. Evans.

The drainage area above the station is 210 square miles.

Discharge Measurements of Shavers Fork River at Parsons, W. Va.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1910			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
Oct.	14	H. P. Drake..............................	145	275	0.28	2.89	76
1911							
Oct.	13	do	184	558	1.72	4.22	958

Note. No discharge curve or rating table has as yet been constructed for this station.

Daily Gage Heights, in Feet, of Shavers Fork River at Parsons, W. Va.

Day	1910			1911											
	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1	----	2.97	4.54	3.90	5.78	3.06	3.94	3.62	3.60	3.38	2.76	4.64	5.72	3.20	3.90
2	----	2.97	3.54	4.50	4.48	3.26	4.44	3.62	3.60	3.08	2.76	3.74	5.12	3.40	3.90
3	----	3.07	3.54	5.90	4.18	3.26	4.54	3.42	3.60	2.78	2.96	3.54	4.72	3.30	3.80
4	----	2.97	3.74	5.30	4.08	3.26	4.64	3.52	3.40	2.78	2.86	3.44	4.72	3.20	3.70
5	----	2.97	3.54	4.70	3.88	3.26	6.24	3.62	3.40	2.78	2.76	3.34	4.62	3.10	3.80
6	----	3.07	3.24	3.90	3.88	3.36	5.64	3.52	3.60	2.78	2.66	3.34	4.32	4.20	3.60
7	----	2.97	3.24	3.70	3.78	4.56	5.64	3.42	3.80	2.68	1.86	3.14	4.72	5.50	3.40
8	----	2.97	3.14	3.60	3.68	4.46	5.44	3.52	4.00	2.78	2.56	3.24	5.32	4.20	3.50
9	----	2.97	2.94	3.50	3.88	2.96	5.24	3.42	3.90	2.78	2.66	2.94	4.72	4.00	3.40
10	----	2.97	3.04	3.20	3.78	4.16	5.04	3.32	3.80	2.68	2.56	2.74	4.92	3.90	3.30
11	----	2.97	3.14	3.20	3.68	4.06	4.84	3.02	3.90	2.88	2.46	3.74	5.02	3.80	3.20
12	----	2.97	3.14	3.50	3.78	3.96	4.64	3.12	3.80	3.38	2.46	4.34	3.82	3.60	3.30
13	----	2.97	3.14	7.20	3.48	4.46	4.84	3.02	3.80	3.18	2.36	3.74	4.22	3.50	3.40
14	2.89	2.77	2.94	6.50	3.48	4.96	5.04	3.12	4.00	3.08	2.46	3.74	3.90	3.40	3.50
15	2.89	2.97	2.94	5.50	3.38	5.26	5.64	3.22	3.90	2.98	2.56	2.84	4.10	3.40	3.60
16	2.80	2.97	2.94	5.60	3.38	5.06	4.74	2.92	3.80	2.98	2.66	6.74	4.70	3.50	4.00
17	2.89	2.77	2.94	4.50	3.48	3.96	4.44	3.02	3.70	2.98	2.66	5.44	4.00	3.40	4.60
18	2.89	2.87	2.94	4.10	3.58	3.86	4.44	2.92	4.40	2.78	2.56	4.34	7.40	---	4.20
19	2.80	2.87	3.14	3.90	3.48	4.06	4.04	2.82	4.00	2.88	2.56	3.74	5.00	---	4.30
20	2.89	2.87	3.04	3.80	3.68	4.66	4.64	2.82	4.00	2.68	2.56	3.94	4.60	---	4.20
21	2.89	2.77	2.94	3.60	3.58	4.46	4.84	2.92	3.80	2.78	2.66	4.04	4.20	---	4.10
22	2.89	2.87	3.04	4.50	3.48	4.36	5.04	2.82	3.80	2.73	2.66	3.94	4.50	---	3.70
23	3.10	2.87	3.14	4.50	3.28	4.06	4.84	1.92	3.70	2.98	2.86	3.84	4.60	---	4.00
24	3.20	2.87	3.74	4.40	3.28	3.96	4.24	2.62	3.80	2.88	2.66	3.74	4.40	3.70	4.20
25	3.00	2.97	3.74	4.60	3.08	3.86	4.04	2.62	4.00	2.78	2.86	3.74	4.00	3.60	4.60
26	3.00	3.77	3.54	4.80	3.28	3.56	4.14	2.72	3.80	2.78	2.56	3.84	4.00	3.50	5.00
27	3.00	3.57	3.24	5.70	3.28	3.46	4.04	4.22	4.00	2.78	2.46	3.94	3.50	3.60	5.10
28	3.00	3.67	3.24	5.60	3.18	3.46	3.84	4.02	3.80	2.68	2.66	4.04	3.40	3.40	5.00
29	3.03	4.87	3.84	5.30	---	3.66	4.04	3.82	3.70	2.58	2.86	3.94	3.30	3.30	4.90
30	3.01	3.97	5.94	9.90	---	3.86	3.64	3.72	3.40	2.68	2.96	3.74	3.40	3.40	4.60
31	3.00	---	4.84	5.90	---	4.06	---	3.72	---	2.88	6.36	---	3.30	---	5.00

TYGART VALLEY RIVER AT FETTERMAN, W. VA.

This station, situated on the iron highway bridge, about 1000 feet from the B. & O. R. R. station at Fetterman, Taylor Co., W. Va., and about 18 miles above the mouth, was established June 3, 1907, by A. H. Horton, for the U. S. Geological Survey.

A standard chain gage, measuring 32.37 feet from marker to bottom of weight, is located on the left of middle pier on downstream side of bridge.

The southwest corner of the lower right abutment of the bridge, marked with black paint, is 31.46 feet above the zero of the gage. A file mark on the upstream and right edges of the first vertical compression member from the abutment, downstream side of left span, marked above and below with black paint, is 37.01 feet above zero of gage.

Measurements are made from the downstream side of the bridge. The initial point for soundings is the face of right abutment, downstream side of bridge.

The channel is straight for over 500 feet above and below the station. The bed of the stream is hard and firm. The banks are not subject to overflow. There is an extreme range of gage heights of about 26 feet.

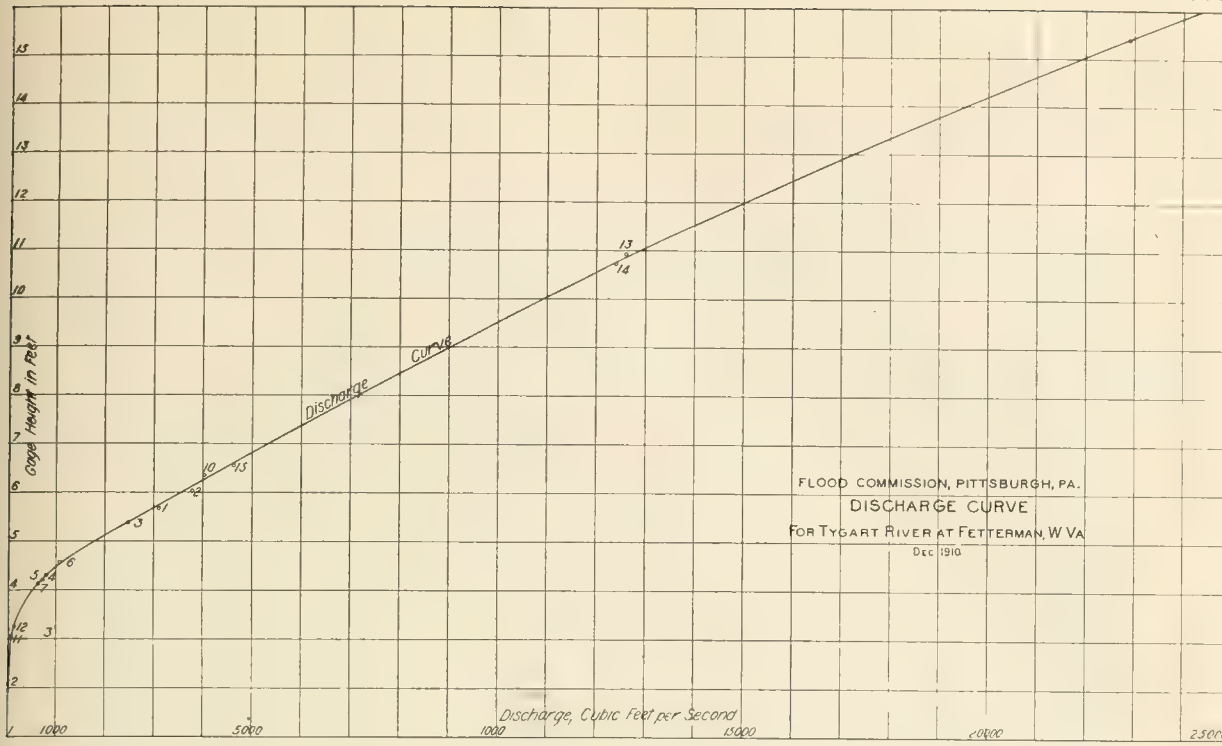
The gage is read twice daily by Joseph Gerken.

The drainage area above the station is 1296 square miles.

Discharge Measurements of Tygart Valley River at Fetterman, W. Va.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1907							
June	3	A. H. Horton	271	1890	1.64	5.68	3100
June	8	do	271	1970	1.92	6.02	3790
Aug.	10	do	271	1800	1.37	5.39	2480
Sept.	15	do	265	1500	0.53	4.30	794
1909							
May	19	do	267	1470	0.49	4.20	722
Nov.	16	do	268	1580	0.68	4.56	1080
Dec.	5	G. L. Parker	269	1410	0.44	4.11	620
1910							
Feb.	18	C. T. Bailey	271	2930	4.03	9.56	11800
Feb.	19	do	271	2470	3.02	7.85	7470
Feb.	21	do	271	2040	1.97	6.35	4020
Aug.	20	do	65	61	1.14	3.05	70
Oct.	8	do	92	95	1.27	3.24	122
1911							
Jan.	16	do	272	3300	3.82	10.92	12600
Jan.	16	do	272	2250	3.82	10.70	12400
Jan.	18	do	272	2130	2.17	6.56	4620
Jan.	31	do	272	4540	5.04	15.39	22900

PLATE 116



Rating Table for Tygart Valley River at Fetterman, W. Va.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.70	0	3.80	384	5.90	3382	8.00	7220	10.10	11190
.80	1	.90	451	6.00	3560	.10	7406	.20	11380
.90	2	4.00	525	.10	3738	.20	7592	.30	11570
2.00	4	.10	607	.20	3916	.30	7780	.40	11760
.10	6	.20	699	.30	4096	.40	7968	.50	11950
.20	9	.30	802	.40	4276	.50	8156	.60	12140
.30	12	.40	916	.50	4456	.60	8344	.70	12330
.40	16	.50	1040	.60	4638	.70	8532	.80	12520
.50	20	.60	1176	.70	4820	.80	8720	.90	12710
.60	25	.70	1324	.80	5002	.90	8910	11.00	12900
.70	32	.80	1484	.90	5186	9.00	9100	12.00	15060
.80	40	.90	1650	7.00	5370	.10	9290	13.00	17300
.90	50	5.00	1820	.10	5554	.20	9480	14.00	19600
3.00	63	.10	1990	.20	5738	.30	9670	15.00	21900
.10	80	.20	2162	.30	5922	.40	9860	16.00	24300
.20	103	.30	2334	.40	6107	.50	10050	17.00	26700
.30	134	.40	2506	.50	6292	.60	10240	18.00	29100
.40	172	.50	2680	.60	6477	.70	10430	19.00	31600
.50	218	.60	2854	.70	6662	.80	10620	20.00	34100
.60	268	.70	3030	.80	6848	.90	10810	.....	.....
.70	323	.80	3206	.90	7034	10.00	11000	.....	.....

Note.—The above table is not applicable for ice or obstructed channel conditions. It is based on 16 discharge measurements made during 1907–1911, and is well defined between gage heights 3.00 feet and 16.00 feet.

Table is furnished through courtesy of U. S. Geological Survey.

Daily Gage Heights and Discharges of Tygart Valley River at Fetterman, W. Va., for 1907.

Day	June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	5.15	2076	4.50	1040	4.30	802	4.12	625	5.40	2506	4.85	1567
2	....	....	6.30	4096	4.40	916	4.25	750	4.10	607	5.50	2680	4.75	1404
3	5.70	3030	6.60	4638	4.30	802	4.25	750	4.08	589	7.40	6107	4.70	1324
4	5.60	2854	5.50	2680	4.28	781	4.25	750	4.10	607	7.75	6755	4.55	1108
5	5.40	2506	4.90	1650	4.15	653	4.65	1250	6.05	3649	6.95	5278	4.50	1040
6	6.60	4638	4.55	1108	4.65	1250	5.00	1820	7.40	6107	6.65	4929	4.35	859
7	6.35	4186	4.55	1108	4.60	1176	4.60	1176	5.55	2767	8.85	8815	4.30	802
8	6.05	3649	4.45	978	4.40	916	4.40	916	5.70	3030	8.95	9005	4.20	699
9	10.90	12710	4.80	1484	4.50	1040	4.25	750	8.65	8438	7.60	6477	4.45	978
10	8.80	8720	9.10	9290	5.25	2248	4.50	1040	6.80	5002	7.05	5462	6.75	4911
11	6.30	4096	8.25	7686	6.10	3738	4.70	1324	5.60	2854	6.90	5186	11.80	14630
12	6.00	3560	8.15	7499	5.05	1905	4.95	1735	5.15	2076	6.60	4638	8.40	7968
13	6.40	4276	8.15	7499	4.60	1176	4.65	1250	4.90	1650	6.00	3560	6.55	4547
14	13.30	17990	7.20	5738	4.35	859	4.45	978	4.75	1404	5.50	2680	8.00	7220
15	12.60	16400	5.90	3382	4.15	653	4.35	859	4.65	1250	5.15	2076	9.95	10905
16	8.95	9005	5.30	2334	4.00	525	4.15	653	4.55	1108	4.95	1735	9.05	9195
17	6.50	4456	12.70	16630	4.00	525	4.05	566	4.48	1015	4.75	1404	7.00	5370
18	5.70	3030	19.80	33600	4.00	525	4.15	653	4.35	859	4.60	1176	6.15	3827
19	5.25	2238	15.60	23340	4.15	653	5.05	1905	4.15	653	5.00	1820	5.75	3116
20	4.75	1404	9.15	9385	4.05	566	5.00	1820	4.12	623	5.00	1820	5.45	2593
21	4.70	1324	6.75	4911	3.95	488	4.55	1108	4.12	623	5.00	1820	5.05	1905
22	4.55	1108	5.60	2854	3.88	437	4.50	1040	4.10	607	4.90	1650	4.95	1735
23	4.55	1108	5.45	2593	4.15	653	4.40	916	4.02	541	4.80	1484	5.75	3116
24	4.50	1040	5.85	3294	8.60	8344	4.45	978	3.98	510	6.60	4638	8.75	8626
25	5.45	2593	6.45	4366	11.20	13330	4.35	859	3.90	451	8.00	7220	8.30	7780
26	4.55	1108	5.75	3116	9.10	9290	4.30	802	3.80	384	7.20	5738	6.50	4456
27	4.50	1040	5.75	3116	6.20	3916	4.15	653	3.90	451	6.40	4276	5.60	2854
28	4.45	978	5.00	1820	5.45	2593	4.05	566	5.40	2506	5.65	2942	5.45	2593
29	4.25	750	4.55	1108	4.90	1650	4.10	607	7.70	6662	5.45	2593	5.40	2506
30	4.30	802	4.80	1484	4.75	1404	4.20	699	6.55	4547	5.10	1990	5.25	2248
31	....	....	4.85	1567	4.45	978	....	....	5.75	3116	....	....	5.35	2420

Daily Gage Heights and Discharges of Tygart Valley River at Fetterman, W. Va., for 1908.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.40	2506	5.55	2767	5.95	3471	11.00	12900	4.65	1250	5.60	2854	3.60	268	4.35	859	3.25	118	2.60	25	2.40	16	2.70	32
2	5.35	2420	5.50	2680	13.35	18105	10.25	11475	4.75	1404	5.00	1820	3.60	268	3.85	417	3.20	103	2.60	25	2.40	16	2.70	32
3	5.15	2076	5.55	2767	11.05	13008	8.55	8250	4.95	1735	4.75	1404	3.60	268	3.65	295	3.25	118	2.55	22	2.35	14	2.70	32
4	5.05	1905	5.90	3382	8.20	7592	7.20	5738	5.70	3030	4.80	1484	3.50	218	3.60	268	3.25	118	2.50	20	2.30	12	2.75	36
5	5.10	1990	6.15	3827	6.70	4638	5.95	3471	12.75	16740	5.40	2506	3.60	268	3.60	268	3.20	103	2.50	20	2.30	12	2.80	40
6	5.02	1857	10.10	11190	7.20	5738	5.65	2942	13.00	17300	5.50	2680	4.30	802	3.55	243	3.15	91	2.50	20	2.30	12	2.90	50
7	4.95	1735	8.40	7968	9.20	9480	5.35	2420	11.55	14090	4.85	1567	4.35	859	3.50	218	3.10	80	2.50	20	2.30	12	2.95	56
8	4.95	1735	6.60	4638	8.40	7968	5.40	2506	13.45	18335	4.55	1108	4.25	750	3.80	384	3.08	77	2.45	18	2.30	12	3.10	80
9	4.75	1404	5.70	3030	12.10	15284	8.35	7874	10.60	12140	4.40	916	4.10	607	4.00	525	3.02	66	2.40	16	2.30	12	3.10	80
10	4.65	1250	5.50	2680	10.15	11285	8.55	8250	12.55	16290	4.20	699	3.95	488	3.70	323	3.00	63	2.40	16	2.30	12	3.00	63
11	4.70	1324	5.25	2248	8.25	7786	9.65	10335	11.85	14740	4.18	679	3.80	384	3.65	295	2.98	60	2.40	16	2.40	16	3.00	63
12	8.80	8720	5.75	3118	6.70	4820	11.25	13440	8.55	8250	4.12	625	3.60	268	3.65	295	2.92	52	2.45	18	2.40	16	3.25	118
13	14.10	19830	9.10	9290	6.15	3827	8.85	8815	6.30	4096	4.10	607	3.65	295	3.60	268	2.90	50	2.55	22	2.40	16	3.65	295
14	10.20	11380	10.65	12235	5.75	3118	6.60	4638	5.80	3206	3.95	488	3.95	488	3.60	268	2.90	50	2.55	22	2.40	16	3.75	353
15	7.00	5370	13.25	17875	5.60	2854	5.85	3294	5.75	3118	4.00	525	3.95	488	3.60	268	2.85	45	2.50	20	2.45	18	3.85	417
16	6.25	4006	14.30	20290	5.50	2680	5.85	3294	5.50	2680	4.45	978	3.85	417	3.55	243	2.80	40	2.50	20	2.50	20	4.00	525
17	5.95	3471	9.65	10335	5.50	2680	6.45	4366	5.95	3471	4.55	1108	3.85	417	3.50	218	2.80	40	2.50	20	2.50	20	3.85	417
18	5.65	2942	6.85	5093	5.45	2593	6.70	4820	5.85	3294	4.20	699	4.10	607	3.50	218	2.70	32	2.50	20	2.50	20	3.70	323
19	5.55	2593	6.55	4547	8.85	8626	6.30	4096	6.65	4729	4.05	566	4.45	978	3.50	218	2.70	32	2.45	18	2.50	20	3.65	295
20	5.15	2076	7.10	5554	9.50	10050	6.80	5002	7.60	6477	3.95	488	4.50	1040	3.45	195	2.70	32	2.40	16	2.50	20	3.80	384
21	5.00	1820	6.45	4366	7.70	6662	6.90	5186	11.55	14090	3.85	417	4.15	653	3.40	172	2.70	32	2.40	16	2.55	22	3.70	323
22	5.20	2162	5.90	3382	6.60	4638	5.95	3471	9.05	9195	3.80	384	4.05	566	3.40	172	2.70	32	2.40	16	2.60	25	3.75	353
23	5.82	3241	5.65	2942	5.90	3382	5.40	2506	7.25	5830	3.85	417	4.45	978	3.35	153	2.70	32	2.40	16	2.60	25	3.75	353
24	5.85	3294	5.35	2420	5.80	3206	5.15	2076	6.25	4006	4.00	525	4.70	1324	3.30	134	2.70	32	2.40	16	2.60	25	3.70	323
25	5.30	2334	5.20	2162	5.60	2854	5.00	1820	5.70	3030	3.95	488	5.15	2076	3.30	134	2.70	32	2.40	16	2.60	25	3.70	323
26	5.20	2162	5.70	3030	5.40	2506	4.85	1567	5.85	3294	3.90	451	6.70	4820	3.30	134	2.70	32	2.35	14	2.70	32	3.65	295
27	7.45	6199	6.25	4006	5.30	2334	4.75	1404	5.55	2767	3.85	417	7.45	6199	3.30	134	2.70	32	2.30	12	2.70	32	3.60	268
28	7.95	7127	5.90	3382	5.15	2076	4.70	1324	5.15	2076	3.80	384	6.30	4096	3.20	103	2.70	32	2.30	12	2.70	32	3.60	268
29	6.90	5186	5.60	2854	5.60	2854	4.55	1108	4.80	1484	3.75	353	5.55	2767	3.20	103	2.65	29	2.35	14	2.70	32	3.55	243
30	6.00	3560	....	....	7.75	6755	4.50	1040	4.55	1108	3.70	323	5.10	1990	3.15	91	2.60	25	2.40	16	2.70	32	3.55	243
31	5.50	2680	....	....	9.20	9480	....	....	6.60	4638	....	...	4.85	1567	3.10	80	....	..	2.40	16	....	..	3.65	295

Daily Gage Heights and Discharges of Tygart Valley River at Fetterman, W. Va., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.80	384	4.80	1484	5.85	3294	5.80	3206	7.65	6569	4.00	566
2	4.20	699	4.65	1250	5.65	2942	5.65	2942	9.65	10335	3.90	451
3	4.35	859	4.55	1108	6.15	3827	5.80	3206	8.70	8532	4.05	566
4	4.40	916	4.45	978	8.00	7220	5.85	3294	6.90	5186	4.05	566
5	4.45	978	4.50	1040	7.25	5830	6.70	4820	6.15	3827	4.60	1176
6	4.40	916	5.05	1905	6.50	4456	7.00	5370	5.75	3118	6.05	3649
7	4.20	699	5.65	2942	6.50	4456	6.55	4547	5.55	2767	5.10	1990
8	4.45	978	5.70	3030	7.40	6107	5.80	3206	5.20	2162	5.15	2076
9	4.60	1176	5.65	2942	7.30	5922	5.50	2680	4.85	1567	7.15	5646
10	4.35	859	7.45	6199	6.85	5093	5.35	2420	4.80	1484	6.55	4547
11	4.40	916	8.65	8438	6.65	4729	5.50	2680	4.95	1735	8.95	9005
12	4.60	1176	6.80	5002	6.10	3738	4.85	3294	4.90	1650	6.80	5002
13	4.55	1108	6.20	3916	5.65	2942	4.80	3206	4.85	1567	5.95	3471
14	4.50	1040	5.95	3471	5.60	2854	9.30	9670	4.80	1484	5.40	2506
15	7.70	6662	5.95	3471	5.80	3206	11.50	13980	4.70	1324	5.75	3118
16	9.60	10240	9.30	9670	5.70	3030	7.80	6848	4.55	1108	5.80	3206
17	8.90	8910	8.70	8532	5.45	2593	6.45	4366	4.45	978	5.25	2248
18	7.60	6477	7.35	6015	5.25	2248	5.65	2942	4.20	699	9.85	10705
19	5.90	3382	6.60	4638	4.95	1735	5.40	2506	3.95	488	7.30	5922
20	5.65	2942	6.20	3916	4.90	1650	6.10	3738	4.00	525	5.85	3294
21	5.45	2593	5.95	3471	4.85	1567	8.20	7592	4.05	566	5.20	2162
22	5.30	2334	6.45	4366	4.70	1324	11.45	13870	4.15	653	4.65	1250
23	5.15	2076	6.55	4547	4.65	1250	11.05	13008	4.20	699	4.50	1040
24	5.30	2334	8.50	8156	4.45	978	9.25	9575	4.20	699	4.35	859
25	5.35	2420	10.05	11095	4.55	1108	8.30	7780	4.15	653	4.25	750
26	4.80	1484	7.75	6755	4.75	1404	7.60	6477	4.00	525	4.15	653
27	4.65	1250	6.70	4820	5.60	2854	6.40	4276	4.10	607	4.10	607
28	4.50	1040	6.15	3827	6.20	3916	6.05	3649	4.50	1040	4.90	1650
29	4.55	1108	....	....	6.60	4638	5.75	3118	4.35	859	5.10	1990
30	4.65	1250	....	....	6.55	4547	6.05	3649	4.15	653	4.60	1176
31	4.80	1484	....	....	6.40	4276	....	....	4.05	566	....	....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.45	978	5.65	2942	3.50	218	3.80	384	4.30	802	4.30	802
2	4.30	802	4.80	1484	3.50	218	3.80	384	4.25	750	4.25	750
3	4.15	653	4.65	1250	3.55	243	3.75	353	4.15	653	4.15	653
4	4.05	566	4.50	1040	3.65	295	3.65	295	4.10	607	4.10	607
5	3.90	451	4.10	607	3.70	323	3.60	268	4.10	607	4.10	607
6	3.75	353	3.90	451	3.55	243	3.50	218	4.05	566	4.05	566
7	3.65	295	3.80	384	3.50	218	3.50	218	4.00	525	4.05	566
8	3.50	218	3.70	323	3.50	218	3.40	172	3.90	451	4.15	653
9	3.45	195	3.65	295	3.50	218	3.40	172	3.90	451	4.10	607
10	3.40	172	3.60	268	4.75	1404	3.40	172	5.65	2942	3.95	488
11	3.40	172	3.50	218	5.45	2593	3.40	172	8.00	7220	3.90	451
12	3.45	195	3.50	218	4.80	1484	3.80	384	6.20	3916	4.10	607
13	3.60	268	3.45	195	4.45	978	4.40	916	5.50	2680	4.20	699
14	3.55	243	3.35	153	4.10	607	4.35	859	5.15	2076	5.15	2076
15	3.45	195	3.35	153	3.95	488	4.30	802	4.90	1650	5.85	3294
16	3.55	243	3.60	268	3.85	417	4.10	607	4.65	1250	5.75	3118
17	3.70	323	4.30	802	6.55	4547	3.90	451	4.50	1040	5.15	2076
18	3.65	295	5.05	1905	4.75	1404	4.15	653	4.40	916	4.85	1567
19	3.60	268	4.70	1324	4.50	1040	4.15	653	4.40	916	4.60	1176
20	3.45	195	4.30	802	4.25	750	4.85	1567	4.25	750	4.45	978
21	3.40	172	4.20	699	3.90	451	5.10	1990	4.15	653	4.25	750
22	3.35	153	4.60	1176	3.80	384	4.95	1735	4.05	566	4.20	699
23	3.30	134	4.30	802	3.70	323	5.80	3206	4.00	525	4.20	699
24	3.30	134	4.10	607	3.90	451	12.75	16740	4.30	802	4.15	653
25	3.55	243	3.90	451	4.70	1324	11.20	13330	4.70	1324	4.10	607
26	3.90	451	3.75	353	4.60	1176	7.85	6941	4.70	1324	4.00	525
27	4.15	653	3.65	295	4.20	699	6.30	4096	4.55	1108	3.90	451
28	3.90	451	3.50	218	4.10	607	5.30	2334	4.40	916	3.70	323
29	3.70	323	4.65	1250	3.95	488	4.90	1650	4.35	859	3.70	323
30	4.15	653	4.25	750	3.90	451	4.65	1250	4.30	802	3.60	268
31	6.20	3916	3.55	243	....	...	4.55	1108	....	...	3.50	218

Ice conditions Dec. 15–31. River frozen over Dec. 22. Thickness of ice Dec. 31, 0.3 foot. Gage heights Dec. 26–30 interpolated by comparison with river at Belington, W. Va.

Daily Gage Heights and Discharges of Tygart Valley River at Fetterman, W. Va., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	b4.60	1176	5.60	2854	5.75	3118	3.95	488	4.70	1324	4.70	1324	4.30	802	4.35	859	3.10	80	3.55	243	3.70	323	5.20	2162
2	5.90	3382	5.20	2162	6.10	3738	3.90	451	4.55	1108	5.05	1905	4.10	607	3.95	488	3.25	118	3.60	268	3.80	384	4.70	1324
3	a13.40	18220	6.10	3738	6.95	3471	3.90	451	4.45	978	5.70	3030	4.30	802	3.70	323	3.35	153	3.45	195	3.70	323	4.45	978
4	13.25	17875	6.70	4820	5.65	2942	3.90	451	4.40	916	6.05	3649	4.60	1176	3.55	243	3.60	268	3.40	172	3.70	323	4.35	859
5	9.30	9670	6.35	4186	5.40	2506	4.05	566	4.30	802	5.65	2942	4.85	1567	3.45	195	3.55	243	3.40	172	3.70	323	4.30	802
6	7.15	5646	6.20	3916	5.15	2076	4.15	653	4.30	802	8.50	8156	4.75	1404	3.45	195	3.55	243	3.30	134	3.70	323	4.35	859
7	12.95	17190	6.15	3827	5.05	1905	4.10	607	4.25	750	9.20	9480	4.65	1250	3.45	195	3.95	488	3.20	103	3.70	323	4.35	859
8	10.25	11475	5.95	3471	4.95	1735	4.10	607	4.20	699	6.85	5093	5.30	2334	3.45	195	4.00	525	3.30	134	3.70	323	4.30	802
9	7.80	6848	5.60	2854	4.75	1404	4.10	607	4.40	916	6.20	3916	4.95	1735	3.45	195	3.90	451	3.15	91	3.70	323	4.30	802
10	6.40	4276	5.95	3471	4.65	1250	4.05	566	4.80	1484	5.75	3118	4.60	1176	3.45	195	3.70	323	3.10	80	3.60	268	4.30	802
11	5.45	2593	6.65	4729	4.55	1108	4.00	525	4.95	1735	5.90	3382	4.40	916	3.40	172	3.65	295	3.10	80	3.65	295	4.30	802
12	5.05	1905	7.15	5646	4.50	1040	4.00	525	6.25	4006	6.05	3649	4.30	802	3.20	103	3.60	268	3.10	80	3.70	323	b4.30	802
13	5.00	1820	8.05	7313	4.45	978	4.00	525	8.90	8910	6.50	4456	4.35	859	3.15	91	3.65	295	3.10	80	3.70	323	b4.30	802
14	7.35	6015	8.30	7780	4.40	916	4.00	525	7.15	5646	6.35	4186	5.25	2248	3.10	80	4.40	172	3.05	71	3.60	268	b4.30	802
15	8.25	7786	8.15	7499	4.35	859	4.20	699	5.90	3382	6.00	3560	5.45	2593	3.05	71	4.15	653	3.05	71	3.50	218	b4.20	699
16	7.00	5370	7.80	6848	4.25	750	4.25	750	5.35	2420	8.60	8344	5.00	1820	3.25	118	4.10	607	3.15	91	3.50	218	b4.05	566
17	6.10	3738	9.70	10430	4.20	699	4.20	699	5.00	1820	14.50	20720	4.70	1324	3.20	103	3.90	451	3.10	80	3.50	218	b4.05	566
18	9.30	9670	9.45	9955	4.20	699	4.35	859	4.85	1567	11.35	13655	4.55	1108	3.10	80	3.75	353	3.10	80	3.45	195	b4.10	607
19	13.80	19140	8.25	7786	4.15	653	4.35	859	4.70	1324	11.65	14305	4.40	916	3.00	63	3.65	295	3.10	80	3.40	172	b4.20	699
20	10.05	11095	7.40	6107	4.10	607	4.45	978	4.60	1176	12.70	16630	4.35	859	2.90	50	3.55	243	3.10	80	3.40	172	b4.75	1404
21	8.90	8910	6.65	4729	4.10	607	4.65	1250	4.55	1108	8.25	7786	4.30	802	2.95	56	3.50	218	3.00	63	3.40	172	b5.15	2076
22	9.95	10905	8.90	8910	4.10	607	4.95	1735	4.50	1040	6.65	4729	4.10	607	2.90	50	3.45	195	3.00	63	3.40	172	b4.75	1404
23	7.80	6848	10.15	11285	4.15	653	5.55	2767	4.40	916	6.20	3916	3.90	451	2.90	50	3.40	172	3.00	63	3.40	172	b4.55	1108
24	6.50	4456	7.60	6477	4.10	607	4.85	1567	4.35	859	5.70	3030	3.80	384	2.85	45	3.40	172	3.00	63	3.40	172	b5.60	2854
25	5.85	3294	6.40	4276	4.05	566	6.90	5186	4.75	1404	5.25	2248	3.60	268	3.00	63	3.30	134	3.00	63	3.40	172	8.80	8720
26	5.55	2767	5.75	3118	4.00	525	6.50	4456	5.55	2767	4.90	1650	3.50	218	3.30	134	3.40	172	3.00	63	3.45	195	7.55	6384
27	7.75	6755	5.40	2506	4.00	525	5.90	3382	5.50	2680	4.70	1324	3.45	195	3.15	91	3.20	103	3.05	71	3.50	218	6.90	5186
28	9.00	9100	5.40	2506	4.00	525	5.55	2767	5.15	2076	4.50	1040	3.40	172	3.10	80	3.15	91	3.10	80	4.40	916	6.20	3916
29	7.40	6107	....	....	4.00	525	5.20	2162	4.90	1650	4.35	859	3.35	153	3.05	71	3.05	71	3.10	80	5.90	3382	5.70	3030
30	6.50	4456	....	....	4.00	525	4.90	1650	4.80	1484	4.30	802	3.50	218	3.00	63	3.30	134	3.20	103	5.70	3030	7.75	6755
31	5.95	3471	....	....	4.00	525	....	....	4.60	1176	....	...	4.15	653	3.00	63	....	..	3.50	218	....	....	9.15	9385

a. Max. 16.6 = 25740 sec.-ft. b. Interpolated from gage heights at Belington, W. Va.

Daiy Gage Heights and Discharges of Tygart Valley River at Fetterman, W. Va., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	7.10	5554	9.50	10050	5.60	2854	6.65	4729	4.85	1567	3.50	218	3.85	417	3.00	63
2	7.35	6014	7.00	5370	5.35	2420	6.40	4276	4.75	1404	3.50	218	3.75	353	3.00	63
3	8.55	8250	6.50	4456	5.25	2248	6.10	3738	4.55	1108	3.50	218	3.70	323	3.00	63
4	8.75	8626	6.25	4006	5.10	1990	7.85	6941	4.50	1040	3.50	218	3.65	295	3.00	63
5	7.20	5738	5.95	3471	4.85	1567	11.60	14196	4.35	859	3.45	195	3.50	218	3.00	63
6	6.15	3827	5.45	2593	4.75	1404	9.75	10525	4.30	802	3.40	172	3.45	195	2.95	56
7	5.40	2506	5.50	2680	6.75	4911	8.05	7313	4.30	802	4.20	699	3.50	218	2.90	50
8	5.15	2076	5.50	2680	7.60	6477	7.70	6662	4.25	750	4.05	566	3.90	451	3.35	153
9	5.40	2506	5.70	3030	7.45	6199	8.75	8626	4.15	653	3.95	488	3.60	268	3.50	218
10	4.85	1567	6.00	3560	7.10	5554	8.80	8720	4.10	607	4.15	653	3.95	488	3.40	172
11	4.70	1324	5.70	3030	6.85	5093	7.80	6848	4.05	566	3.90	451	3.90	415	3.35	153
12	4.85	1567	5.35	2420	6.65	4729	6.65	4728	4.00	525	4.05	566	3.75	353	3.25	118
13	11.50	13980	5.15	2076	6.30	4096	5.65	2942	3.90	451	3.95	488	3.90	451	3.20	103
14	14.80	21440	4.95	1735	6.30	4096	5.45	2593	3.90	451	4.35	859	3.95	488	3.20	103
15	10.50	11950	4.90	1650	6.50	4456	7.65	6570	3.85	417	4.65	1250	3.75	353	3.20	103
16	10.75	12425	4.85	1567	6.30	4096	7.70	6662	3.75	353	4.60	1176	3.55	243	3.20	103
17	8.15	7499	4.55	1108	5.85	3294	6.55	4547	3.65	295	4.30	802	3.45	195	3.20	103
18	6.45	4366	4.45	978	5.65	2942	5.85	3294	3.55	243	5.50	2680	3.40	172	3.15	91
19	5.55	2757	4.30	802	6.30	4096	5.55	2757	3.50	218	6.50	4456	3.35	153	3.10	80
20	5.30	2334	5.50	2680	7.40	6107	5.65	2942	3.45	195	5.90	3382	3.30	134	3.10	80
21	5.20	2162	6.10	3738	7.20	5738	6.80	5002	3.75	353	5.50	2680	3.25	118	3.05	71
22	6.15	3827	5.85	3294	6.75	4911	7.40	6107	3.95	488	4.75	1404	3.20	103	3.00	63
23	7.65	6570	5.25	2248	6.20	3916	7.85	6941	3.85	417	4.25	750	3.20	103	3.00	63
24	6.95	5278	5.20	2162	5.70	3030	7.50	6292	3.65	295	4.15	653	3.20	103	2.95	56
25	6.10	3738	5.20	2162	5.30	2334	6.90	5186	3.55	243	4.10	607	3.30	134	2.90	50
26	6.15	3827	5.25	2248	5.15	2076	6.15	3827	3.50	218	4.75	1404	3.30	134	3.00	63
27	11.40	13764	5.40	2506	5.05	1905	5.70	3030	3.50	218	5.00	1820	3.25	118	3.15	91
28	10.70	12330	5.65	2942	4.95	1735	5.30	2334	3.60	268	4.95	1735	3.15	91	3.35	153
29	10.30	11570	....	....	4.95	1735	5.10	1990	3.60	268	4.50	1040	3.05	71	5.15	2076
30	20.35	34975	....	....	5.20	2162	4.90	1650	3.55	243	4.10	607	3.00	63	6.65	4729
31	15.95	24180	....	....	6.40	4276	....	....	3.50	218	....	....	3.00	63	10.10	11190

Estimated Monthly Discharge of Tygart Valley River at Fetterman, W. Va.

[Drainage area, 1,327 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
June	17990	750	4307	3.426	3.569
July	33600	978	5691	4.281	4.935
August	13330	437	2098	1.581	1.823
September	1905	566	999	0.751	0.838
October	8438	384	2107	1.588	1.831
November	9005	1176	3949	2.976	3.321
December	14630	699	3777	2.846	3.281
1908					
January	19830	1250	3883	2.926	3.373
February	20290	2162	5312	4.003	4.317
March	18105	2076	6205	4.676	5.391
April	13440	1040	4981	3.752	4.186
May	18335	1108	6577	4.957	5.715
June	2854	323	932	0.702	0.783
July	6199	218	1200	0.904	1.042
August	859	80	248	0.187	0.216
September	118	25	56	0.042	0.047
October	25	12	18	0.013	0.015
November	32	12	19	0.014	0.016
December	384	32	225	0.169	0.195
The year	20290	12	2471	1.862	25.296

Estimated Monthly Discharge of Tygart Valley River at Patterson, W. Va.,—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
January	10240	384	2280	1.718	1.981
February	11095	978	4535	3.417	3.558
March	7220	978	3411	2.570	2.963
April	13980	2420	5397	4.075	4.546
May	10335	488	2085	1.571	1.811
June	10705	451	2728	2.056	2.294
July	3916	134	463	0.349	0.402
August	2942	153	707	0.533	0.615
September	4547	218	809	0.609	0.679
October	16740	172	2067	1.558	1.797
November	7220	451	1321	0.996	1.111
December	3294	218	899	0.677	0.780
The year	16740	134	2224	1.677	22.537
1910					
January	25740	1820	7482	5.638	6.500
February	11285	2162	5471	4.123	4.293
March	3738	525	1247	0.939	1.083
April	5186	451	1310	0.987	1.101
May	8910	699	1901	1.432	1.651
June	20720	802	5429	4.091	4.564
July	2593	153	981	0.739	0.852
August	859	45	154	0.116	0.134
September	607	71	266	0.200	0.223
October	268	63	107	0.081	0.093
November	3382	172	474	0.357	0.398
December	9385	566	2220	1.673	1.929
The year	25740	45	2254	1.698	22.821
1911					
January	34975	1324	8017	6.186	7.132
February	10050	802	2902	2.239	2.332
March	6477	1404	3627	2.799	3.227
April	14196	1650	5399	4.166	4.648
May	1567	195	533	0.411	0.474
June	4456	172	1082	0.835	0.931
July	488	63	236	0.182	0.210
August	11190	50	664	0.512	0.590

TYGART VALLEY RIVER AT BELINGTON, W. VA.

This station, situated on the highway bridge at Belington, Barbour Co., W. Va., 60 miles above the mouth, was established June 5, 1907, by A. H. Horton, for the U. S. Geological Survey.

A standard chain gage, measuring 13.02 feet from high-water marker and 23.02 feet from low-water marker to bottom of weight, is installed at this station.

A point on the curb, about 50 feet from bridge abutment on south side of river, marked "Bench Mark," is 19.85 feet above the zero of the gage. The overhang over center pier, directly over vertical reinforcing angle-iron, is 22.07 feet above the zero of the gage. The top of the bottom angle iron of bridge rail immediately over center of gage pulley is 22.83 feet above the zero of the gage.

Measurements are made from upstream side of bridge. The initial point for soundings is the left end of guardrail, upstream side of bridge.

Both banks are subject to overflow at extremely high stages. The bed of the river is gravelly.

The gage is read daily by S. A. Campbell.

The drainage area above the station is 404 square miles.

Discharge Measurements of Tygart Valley River at Belington, W. Va.

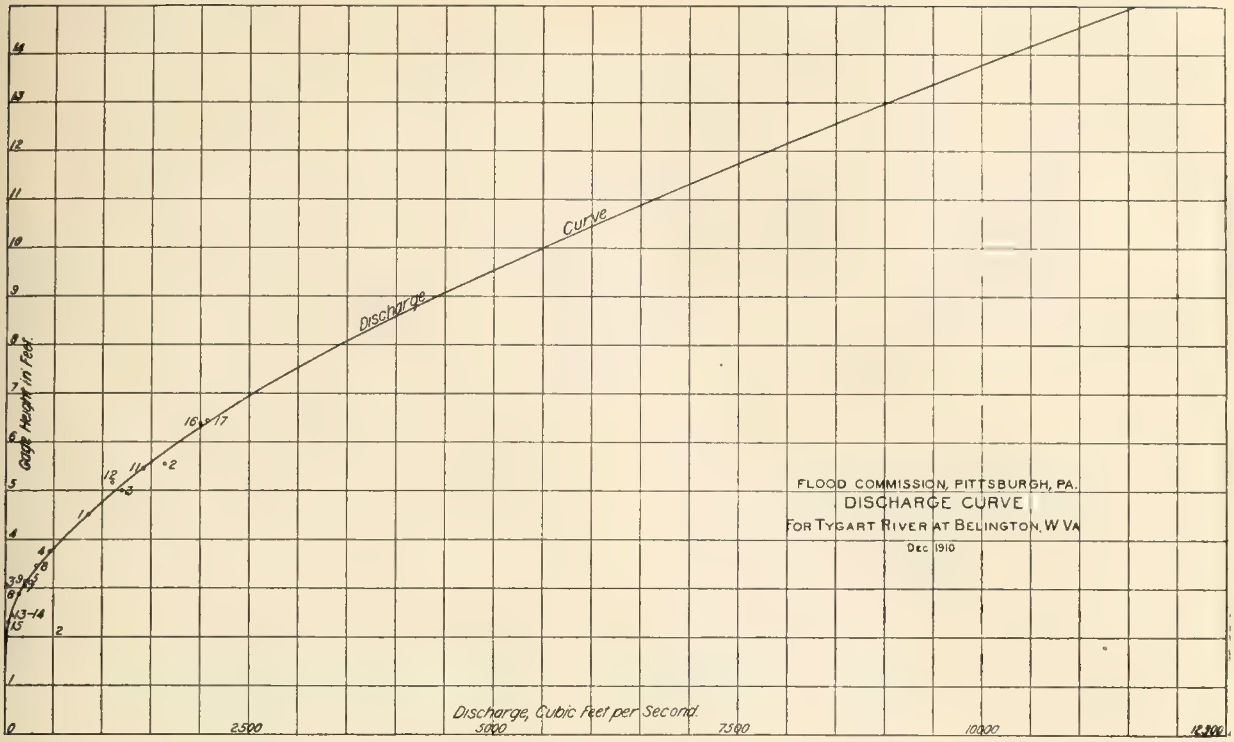
Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Dis-charge
			Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
1907							
June	5	A. H. Horton	189	604	1.41	4.50	856
June	6	C. E. Langley	196	838	1.96	5.54	1640
June	7	A. H. Horton	193	718	1.68	4.99	1200
Aug.	12	do	186	468	0.98	3.73	459
Sept.	16	do	174	349	0.67	3.14	233
1908							
Aug.	2	W. G. Hoyt	180	303	0.49	2.87	147
1909							
May	20	A. H. Horton	180	327	0.67	3.05	2
Nov.	17	do	186	395	0.83	3.44	3
Dec.	4	G. L. Parker	186	342	0.66	3.11	2
1910							
Feb.	17	C. T. Bailey	213	1560	3.44	9.08	5360
Feb.	20	do	200	813	1.75	5.46	1420
Feb.	20	do	200	757	1.45	5.15	11
Aug.	22	do	180	212	0.36	2.44	75
Oct.	13	do	178	194	0.17	2.29	32
Oct.	10	H. P. Drake	173	223	0.34	2.43	76
1911							
Jan.	17	C. T. Bailey	205	988	2.03	6.38	2000
Feb.	1	do	205	986	2.11	6.43	2080

Rating Table for Tygart Valley River at Belington, W. Va.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.50	0	4.30	745	7.10	2620	9.90	5390	12.70	8675
.60	1.5	.40	797	.20	2702	10.00	5500	.80	8800
.70	4	.50	850	.30	2786	.10	5610	.90	8925
.80	7	.60	904	.40	2872	.20	5720	13.00	9050
.90	12	.70	959	.50	2960	.30	5835	.10	9175
2.00	18	.80	1015	.60	3048	.40	5950	.20	9300
.10	26	.90	1072	.70	3138	.50	6065	.30	9425
.20	36	5.00	1130	.80	3230	.60	6180	.40	9550
.30	47	.10	1189	.90	3324	.70	6295	.50	9675
.40	59	.20	1249	8.00	3420	.80	6410	.60	9800
.50	73	.30	1310	.10	3518	.90	6525	.70	9925
.60	90	.40	1372	.20	3616	11.00	6640	.80	10050
.70	110	.50	1435	.30	3714	.10	6755	.90	10175
.80	132	.60	1499	.40	3812	.20	6870	14.00	10300
.90	156	.70	1565	.50	3910	.30	6990	.10	10425
3.00	183	.80	1633	.60	4010	.40	7110	.20	10550
.10	213	.90	1703	.70	4110	.50	7230	.30	10675
.20	246	6.00	1775	.80	4210	.60	7350	.40	10800
.30	282	.10	1849	.90	4310	.70	7470	.50	10930
.40	321	.20	1923	9.00	4410	.80	7590	.60	11060
.50	363	.30	1998	.10	4515	.90	7710	.70	11190
.60	407	.40	2074	.20	4620	12.00	7830	.80	11320
.70	452	.50	2150	.30	4730	.10	7950	.90	11450
.80	498	.60	2226	.40	4840	.20	8070	15.00	11580
.90	546	.70	2304	.50	4950	.30	8190	16.00	12880
4.00	595	.80	2382	.60	5060	.40	8310	17.00	14180
.10	644	.90	2460	.70	5170	.50	8430	18.00	15530
.20	694	7.00	2540	.80	5280	.60	8550	19.00	16880

Note.—The above table is not applicable for ice or obstructed channel conditions. It is based on 17 discharge measurements made during 1907-1911, and is well defined between gage heights 2.0 and 7.0 feet. Table is furnished by U. S. Geological Survey.

PLATE 117



Daily Gage Heights and Discharges of Tygart Valley River at Belington, W. Va., for 1907.

Day	June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	3.50	363	3.90	546	3.00	183	3.20	246	4.10	644	3.90	546
2	....	....	3.90	546	3.40	321	3.10	213	3.10	213	4.00	595	3.70	452
3	....	....	5.60	1499	3.30	282	3.20	246	3.00	183	5.20	1189	3.50	363
4	....	....	5.10	1189	3.10	213	3.50	363	3.10	213	6.30	1998	3.40	321
5	4.50	850	4.10	644	3.30	282	4.60	904	5.60	1499	5.90	1703	3.60	407
6	5.60	1499	3.50	363	3.40	321	4.10	644	4.80	1015	5.30	1310	3.70	452
7	5.00	1130	3.70	452	3.20	246	3.50	363	4.20	694	8.20	3616	3.60	407
8	4.80	1015	4.10	644	3.20	246	3.10	213	4.90	1072	7.10	2620	3.50	363
9	10.80	6410	4.70	959	2.90	156	3.00	183	5.80	1633	6.30	1998	3.40	321
10	6.70	2304	9.20	4620	3.50	363	2.80	132	5.20	1189	6.60	2226	5.20	1249
11	5.40	1372	5.90	1703	4.00	595	3.10	183	4.30	745	7.30	2786	8.90	4310
12	5.00	1130	7.60	3048	3.70	452	4.00	595	4.00	595	6.10	1849	6.30	1998
13	9.30	4730	8.10	3518	3.40	321	4.10	644	3.60	407	5.30	1310	5.40	1372
14	10.10	5610	7.90	3324	3.20	246	3.60	407	3.40	321	4.40	797	6.00	1775
15	11.70	7470	5.10	1189	3.10	213	3.30	282	3.30	282	4.20	694	9.30	4730
16	11.20	6870	4.10	644	3.00	183	3.20	246	3.10	213	3.90	546	7.10	2620
17	5.30	1310	7.10	2620	3.20	246	3.40	321	3.10	213	3.80	498	6.20	1923
18	4.90	1072	18.70	16475	3.50	363	3.20	246	3.20	246	3.60	407	5.10	1189
19	4.00	595	6.20	1923	3.30	282	4.90	1072	3.10	213	3.50	363	4.70	959
20	3.90	546	5.60	1499	3.20	246	4.10	644	3.00	183	3.40	321	4.50	850
21	3.80	498	5.00	1130	3.00	183	3.70	452	2.90	156	3.20	246	4.20	694
22	3.50	363	4.10	644	2.80	132	3.40	321	2.90	156	3.30	282	3.90	546
23	3.40	321	4.50	850	3.10	213	3.10	213	2.80	132	3.40	321	4.10	644
24	3.30	282	4.40	797	10.00	5500	3.50	363	2.80	132	6.10	1849	9.30	4730
25	4.40	797	4.60	904	8.60	4010	3.80	498	2.80	132	7.80	3230	7.10	2620
26	4.10	644	4.60	904	4.90	1072	3.20	246	2.70	110	6.20	1923	6.00	1775
27	3.70	452	4.50	850	4.10	644	3.00	180	2.90	156	5.30	1310	4.70	959
28	3.50	363	4.10	644	3.80	498	2.90	156	3.50	363	4.60	904	4.30	745
29	3.40	321	5.10	1189	3.50	363	3.00	183	6.50	2150	4.30	745	4.20	694
30	3.20	246	4.80	1015	3.30	282	3.10	213	6.20	1923	3.90	546	4.70	959
31	....	....	4.60	904	3.20	246	....	...	5.80	1633	....	...	5.10	1189

Daily Gage Heights and Discharges of Tygart Valley River at Belington, W. Va., for 1908.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gag Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.90	1072	4.30	745	4.40	797	10.10	5610	3.80	498	4.70	959
2	4.70	959	6.10	1849	12.30	8190	7.80	3230	3.90	546	4.10	644
3	4.50	850	5.90	1703	9.10	4515	7.00	2540	4.10	644	3.90	546
4	4.20	694	5.50	1435	6.90	2460	5.80	1633	4.30	745	4.00	595
5	4.40	797	5.30	1310	5.60	1499	4.90	1072	8.90	4310	6.30	1998
6	4.60	904	7.10	2620	6.20	1923	4.60	904	10.80	6410	4.90	1072
7	4.30	745	7.30	2786	8.50	3910	4.30	745	7.90	3324	4.20	694
8	6.20	1923	6.20	1923	7.30	2786	4.40	797	10.70	6295	3.90	546
9	6.90	2460	5.70	1565	7.00	2540	7.50	2960	7.80	3230	3.50	363
10	6.70	2304	4.80	1015	6.80	2382	7.70	3138	10.90	6525	3.30	282
11	6.40	2074	4.60	904	6.40	2074	8.90	4310	10.40	5950	3.10	213
12	10.00	5500	6.20	1923	5.30	1310	8.70	4110	6.70	2304	3.20	246
13	11.50	7230	9.10	4515	4.90	1072	6.60	2226	5.60	1499	3.10	213
14	8.20	3616	10.50	6065	4.60	904	5.30	1310	4.50	850	3.00	183
15	5.90	1703	10.40	5950	4.50	850	4.70	959	4.30	745	3.20	246
16	5.10	1189	12.90	8925	4.60	904	5.10	1189	5.80	1633	3.30	282
17	4.80	1015	7.10	2620	4.50	850	6.70	2304	5.00	1130	3.40	321
18	4.50	850	6.20	1923	4.70	959	5.60	1499	4.20	694	3.00	183
19	4.30	745	5.30	1310	5.80	1633	5.80	1633	4.70	959	2.90	156
20	4.20	694	5.20	1249	8.30	3714	6.50	2150	7.30	2786	3.10	213
21	4.30	745	4.90	1072	6.50	2150	5.70	1565	8.20	3616	3.20	246
22	4.50	850	4.40	797	5.10	1189	4.80	1015	7.40	2872	3.30	282
23	5.90	1703	4.10	644	4.80	1015	4.50	850	6.20	1923	3.10	213
24	5.60	1499	4.00	595	4.70	959	3.90	546	4.90	1072	3.00	183
25	5.40	1372	3.80	498	4.50	850	3.80	498	4.60	904	2.90	156
26	4.20	694	3.90	546	4.30	745	4.10	644	6.40	2074	2.90	156
27	6.30	1998	4.50	850	4.00	595	4.20	694	5.20	1249	2.80	132
28	6.60	2226	4.30	745	4.10	644	4.30	745	4.50	850	2.80	132
29	5.70	1565	4.00	595	4.60	904	4.00	595	4.10	644	2.70	110
30	5.40	1372	....	...	6.50	2150	3.90	546	8.30	3714	2.60	90
31	4.50	850	....	...	6.40	2074	....	...	6.20	1923	....	...

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	2.50	73	3.00	183	2.20	36	1.90	12	1.80	7	2.10	26
2	2.40	59	2.80	132	2.20	36	1.90	12	1.80	7	2.10	26
3	2.30	47	2.20	36	2.20	36	1.90	12	1.90	12	2.10	26
4	3.10	213	2.60	90	2.10	26	1.80	7	1.80	7	2.10	26
5	4.60	904	2.90	156	2.10	26	1.80	7	2.00	18	2.10	26
6	3.80	498	3.20	246	2.10	26	1.80	7	2.10	26	2.20	36
7	3.40	321	2.70	110	2.10	26	1.80	7	2.20	36	2.20	36
8	3.20	246	2.70	110	2.10	26	1.80	7	2.10	26	2.20	36
9	3.10	213	2.80	132	2.00	18	1.80	7	2.00	18	2.20	36
10	3.00	183	2.90	156	2.00	18	1.80	7	2.00	18	2.20	36
11	2.90	156	2.80	132	2.00	18	1.80	7	2.00	18	2.30	47
12	2.60	90	2.90	156	2.00	18	1.80	7	2.00	18	2.50	73
13	2.70	110	2.60	90	2.00	18	1.80	7	2.00	18	2.80	132
14	2.60	90	2.50	73	2.00	18	1.70	4	2.00	18	3.00	183
15	3.00	183	2.40	59	2.00	18	1.70	4	2.00	18	2.90	156
16	2.80	132	2.30	47	2.00	18	1.70	4	2.00	18	2.70	110
17	2.60	90	2.30	47	1.90	12	1.80	7	2.00	18	2.60	90
18	3.00	183	2.30	47	1.90	12	1.80	7	2.00	18	2.50	73
19	3.40	321	2.20	36	1.90	12	1.80	7	2.00	18	2.50	73
20	2.90	156	2.20	36	1.90	12	1.80	7	2.00	18	2.80	132
21	2.80	132	2.20	36	1.90	12	1.80	7	2.00	18	3.00	183
22	3.20	246	2.20	36	1.90	12	1.80	7	2.00	18	2.70	110
23	3.20	246	2.20	36	1.80	7	1.80	7	2.00	18	2.80	132
24	3.30	282	2.20	36	1.80	7	1.80	7	2.00	18	2.70	110
25	3.90	546	2.00	18	1.80	7	1.80	7	2.00	18	2.60	90
26	5.90	1703	2.30	47	1.80	7	1.80	7	2.00	18	2.60	90
27	6.90	2460	2.30	47	1.80	7	1.80	7	2.00	18	2.60	90
28	4.60	904	2.40	59	1.80	7	1.80	7	2.00	18	2.60	90
29	4.10	644	2.60	90	1.80	7	1.80	7	2.00	18	2.60	90
30	3.60	407	2.50	73	1.90	12	1.90	12	2.10	26	2.60	90
31	3.30	282	2.30	47	....	..	1.80	7	....	..	2.90	156

Daily Gage Heights and Discharges of Tygart Valley River at Belington, W. Va., for 1909.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.00	183	3.70	452	5.00	1130	4.80	1015	5.70	1565	2.80	132	3.60	407	6.40	2074	2.60	90	2.60	90	3.20	246	3.30	282
2	3.70	452	3.70	452	4.70	959	4.50	850	5.50	1435	3.10	213	3.20	246	4.10	644	2.50	73	2.50	73	3.10	213	3.20	246
3	3.60	407	3.60	407	4.40	797	5.10	1130	5.10	1189	3.30	282	2.90	156	3.70	452	2.40	59	2.50	73	3.20	246	3.20	246
4	3.00	183	3.50	363	6.10	1849	5.70	1565	5.30	1310	3.00	183	2.90	156	3.30	282	2.50	73	2.40	59	3.10	213	3.10	213
5	2.90	156	3.50	363	5.50	1435	6.10	1849	5.10	1189	3.00	183	2.70	110	3.10	213	2.50	73	2.40	59	2.90	156	3.10	213
6	2.90	156	3.90	546	5.10	1189	6.30	1998	4.70	959	5.00	1130	2.50	73	2.90	156	2.60	90	2.30	47	2.90	156	3.00	183
7	3.70	452	4.10	644	5.80	1633	5.50	1435	4.50	850	4.20	694	2.50	73	3.00	183	2.60	90	2.30	47	2.90	156	3.10	213
8	3.40	321	4.60	904	7.80	3230	4.90	1072	4.00	595	4.80	1015	2.50	73	2.80	132	2.50	73	2.30	47	2.80	132	3.10	213
9	3.30	282	4.00	595	6.70	2304	4.30	745	3.90	546	7.00	2540	2.50	73	2.60	90	2.50	73	2.30	47	2.80	132	3.10	213
10	3.20	246	5.80	1633	6.30	1998	4.00	595	3.70	452	5.40	1372	2.50	73	2.60	90	2.60	90	2.30	47	7.50	2960	3.00	183
11	3.00	183	7.40	2872	6.00	1775	3.90	546	4.20	694	5.80	1633	2.40	59	2.50	73	4.20	694	2.20	36	6.60	2226	3.00	183
12	2.90	156	5.50	1435	5.00	1130	3.70	452	4.50	850	5.30	1310	2.30	47	2.50	73	3.80	498	3.30	282	5.20	1249	3.00	183
13	3.00	183	4.70	959	4.50	850	3.60	407	4.10	644	4.90	1072	2.30	47	2.40	59	3.00	183	4.00	595	4.40	797	3.00	183
14	3.30	282	4.90	1072	4.60	904	7.50	2960	3.90	546	4.30	745	2.30	47	2.30	47	2.70	110	3.40	321	4.10	644	4.50	850
15	6.40	2074	5.20	1249	4.90	1072	9.90	5390	3.70	452	4.00	595	2.50	73	2.30	47	2.60	90	3.10	213	3.60	407	5.30	1310
16	7.00	2540	5.30	1310	4.50	850	6.20	1923	3.50	363	4.20	694	2.70	110	3.70	452	4.50	850	3.40	321	3.50	363	4.50	850
17	6.40	2074	6.10	1849	4.30	745	5.00	1130	3.40	321	4.20	694	2.60	90	4.60	904	5.90	1703	3.20	246	3.40	321	4.00	595
18	5.80	1633	5.50	1435	4.00	595	4.50	850	3.20	246	7.50	2960	2.50	73	4.10	644	3.60	407	3.40	321	3.30	282	3.70	452
19	4.20	694	4.90	1072	3.70	452	4.00	595	3.00	183	5.70	1565	2.40	59	3.50	363	3.40	321	4.00	595	3.20	246	4.00	595
20	4.00	595	4.70	959	3.80	498	3.90	546	3.00	183	4.90	1072	2.40	59	3.20	246	3.00	183	4.30	745	3.20	246	4.70	959
21	4.00	595	5.00	1130	3.80	498	6.10	1849	3.10	213	3.70	452	2.40	59	3.40	321	2.80	132	4.50	850	3.10	213	4.80	1015
22	3.80	498	5.50	1435	3.70	452	8.10	3518	3.30	282	3.50	363	2.30	47	3.30	282	2.70	110	3.70	452	3.10	213	4.60	904
23	3.60	407	5.40	1372	3.70	452	8.20	3616	3.30	282	3.20	246	2.50	73	3.20	246	2.60	90	3.60	407	3.20	246	4.40	797
24	3.50	363	5.40	1372	3.60	407	8.90	4310	3.30	282	3.10	213	3.00	183	3.00	183	3.40	321	10.20	5720	3.30	282	4.00	595
25	3.50	363	6.70	2304	3.70	452	7.00	2540	3.20	246	3.00	183	3.00	183	2.80	132	2.70	110	6.40	2074	4.00	595	4.20	694
26	3.50	363	6.10	1849	4.20	694	5.70	1565	3.10	213	2.90	156	2.90	156	2.60	90	2.90	156	5.10	1189	3.80	498	4.10	644
27	3.40	321	5.70	1565	5.20	1249	5.70	1565	3.10	213	2.70	110	2.70	110	2.50	73	3.00	183	4.10	644	3.60	407	4.00	595
28	3.30	282	5.40	1372	5.80	1633	5.30	1310	3.20	246	3.40	321	2.70	110	2.50	73	2.90	156	4.00	595	3.50	363	4.10	644
29	3.20	246	....	....	6.10	1849	5.40	1372	3.30	282	3.40	321	2.60	90	2.40	59	2.80	132	3.70	452	3.30	282	4.00	595
30	3.20	246	....	....	5.50	1435	5.00	1130	3.20	246	3.10	213	2.60	90	2.10	26	2.70	110	3.50	363	3.30	282	3.80	498
31	3.40	321	....	....	5.10	1189	....	....	3.00	183	....	...	8.10	3518	2.80	132	....	...	3.40	321	....	...	3.50	363

Daily Gage Heights and Discharges of Tygart Valley River at Belington, W. Va., for 1910.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	3.60	407	4.20	694	4.90	1072	3.00	183	3.80	498	3.70	452	3.10	213	3.00	183	2.20	36	2.80	132	2.70	110	3.90	546
2	4.10	644	3.80	498	5.40	1372	3.00	183	3.60	407	4.50	850	3.10	213	2.80	132	2.20	36	2.60	90	2.70	110	3.70	452
3	11.40	7110	4.30	745	5.00	1130	3.00	183	3.50	363	4.80	1015	3.00	183	2.60	90	2.30	47	2.50	73	2.70	110	3.80	498
4	10.30	5835	5.00	1130	4.70	959	3.00	183	3.60	407	5.00	1130	3.30	282	2.70	110	2.30	47	2.50	73	2.70	110	3.50	363
5	6.60	2226	5.00	1130	4.40	797	3.20	246	3.40	321	5.30	1310	3.60	407	2.60	90	2.80	132	2.40	59	2.70	110	3.10	213
6	5.60	1499	5.20	1249	4.20	694	3.20	246	3.20	246	8.80	4210	3.90	546	2.60	90	3.00	183	2.30	47	2.60	90	3.80	498
7	9.30	4730	6.80	2382	4.00	595	3.10	213	3.20	246	7.90	2324	3.40	321	2.60	90	3.30	282	2.20	36	2.60	90	3.70	452
8	8.30	3714	6.20	1923	3.90	546	3.20	246	3.20	246	5.70	1565	3.60	407	2.50	73	3.00	183	2.20	36	2.50	73	3.60	407
9	7.50	2960	6.20	1923	3.70	452	3.10	213	3.60	407	4.80	1015	3.90	546	2.40	59	2.90	156	2.20	36	2.50	73	3.60	407
10	4.80	1015	7.80	3230	3.50	363	3.00	183	4.10	644	4.80	1015	3.80	498	2.50	73	2.80	132	2.20	36	2.50	73	3.50	363
11	4.10	644	7.90	3324	3.50	363	3.00	183	4.00	595	5.30	1310	3.80	498	2.40	59	2.70	110	2.70	110	2.50	73	3.30	282
12	3.90	546	8.30	3714	3.50	363	3.00	183	5.40	1372	6.80	2382	3.20	246	2.40	59	2.60	90	2.60	90	2.50	73	3.30	282
13	3.90	546	7.80	3230	3.40	321	3.00	183	8.30	3714	7.20	2702	4.00	595	2.30	47	2.50	73	2.40	59	2.40	59	3.30	282
14	4.80	1015	7.80	3230	3.40	321	3.30	282	5.90	1703	6.30	1998	5.50	1435	2.40	59	3.00	183	2.40	59	2.30	47	3.30	282
15	6.40	2074	7.80	3230	3.40	321	3.50	363	5.40	1372	5.70	1565	4.70	959	2.40	59	3.40	321	2.30	47	2.30	47	3.20	246
16	4.90	1072	10.60	6180	3.40	321	3.40	321	4.20	694	10.35	5890	4.10	644	2.20	36	3.00	183	2.30	47	2.40	59	3.00	183
17	4.60	904	9.00	4410	3.30	282	3.40	321	3.90	546	14.15	10485	4.10	644	2.20	36	2.80	132	2.20	36	2.30	47	3.00	183
18	5.30	1310	8.40	3812	3.30	282	3.40	321	3.80	498	11.50	7230	4.40	797	2.20	36	2.70	110	2.20	36	2.40	59	3.10	213
19	10.80	6410	7.10	2620	3.20	246	3.80	498	3.70	452	11.40	7110	4.20	694	2.00	18	2.60	90	2.20	36	2.40	59	3.20	246
20	7.50	2960	5.50	1435	3.20	246	4.00	595	3.60	407	11.40	7110	3.70	452	2.10	26	2.50	73	2.20	36	2.40	59	3.80	498
21	5.80	1633	5.20	1249	3.10	213	4.00	595	3.60	407	6.50	2150	3.30	282	2.10	26	2.50	73	2.10	26	2.40	59	4.30	745
22	8.00	3420	6.80	2382	3.30	282	4.60	904	3.50	363	6.50	2150	3.20	246	2.50	73	2.40	59	2.20	36	2.40	59	3.80	498
23	7.50	2960	8.20	3616	3.30	282	5.10	1189	3.40	321	6.00	1775	3.00	183	2.60	90	2.40	59	2.20	36	2.40	59	3.60	407
24	5.20	1249	6.10	1849	3.20	246	4.80	1015	3.40	321	4.80	1015	2.80	132	2.40	59	2.30	47	2.20	36	2.40	59	4.80	1015
25	4.60	904	5.10	1189	3.20	246	6.60	2226	4.30	745	4.00	595	2.80	132	2.60	90	2.30	47	2.70	110	2.50	73	6.60	2226
26	4.20	694	4.60	904	3.20	246	5.90	1703	5.10	1189	3.90	546	2.70	110	2.60	90	2.30	47	2.50	73	2.80	132	6.40	2074
27	5.00	1130	4.40	797	3.10	213	5.40	1372	4.40	797	3.50	363	2.70	110	2.40	59	2.30	47	2.50	73	2.80	132	5.40	1372
28	6.80	2382	4.10	644	3.10	213	4.80	1015	4.00	595	3.40	321	2.80	132	2.30	47	2.50	73	2.50	73	3.30	282	4.70	959
29	5.70	1565	....	...	3.10	213	4.40	797	3.80	498	4.00	595	2.90	156	2.20	36	3.00	183	2.60	90	5.40	1372	4.60	904
30	5.40	1372	....	...	3.00	183	4.00	595	3.50	363	3.30	282	3.20	246	2.20	36	3.00	183	2.70	110	4.20	694	7.40	2872
31	4.60	904	....	...	3.00	183	....	...	3.50	363	....	...	3.00	183	2.20	36	....	...	2.80	132	....	....	7.80	3230

Daily Gage Heights and Discharges of Tygart Valley River at Belington, W. Va., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	7.00	2540	6.70	2304	5.00	1130	5.60	1499	3.80	498	2.80	132	3.00	183	2.10	26
2	7.20	2702	6.30	1998	4.70	959	5.40	1372	3.70	452	2.70	110	2.90	156	2.10	26
3	7.60	3048	6.00	1775	4.10	644	5.20	1249	3.60	407	2.60	90	2.80	132	2.10	26
4	7.80	3230	5.30	1310	4.00	595	6.70	2304	3.60	407	2.50	73	2.60	90	2.10	26
5	6.00	1775	5.10	1189	4.00	595	10.10	5610	3.50	363	2.50	73	2.50	73	2.30	47
6	4.80	1015	4.50	850	3.90	546	8.20	3616	3.40	321	2.40	59	2.80	132	3.10	213
7	4.50	850	4.50	850	7.80	3230	6.40	2074	3.40	321	2.50	73	2.60	90	2.70	110
8	4.20	694	4.40	797	6.30	1998	6.40	2074	3.30	282	4.20	694	3.60	407	2.60	90
9	3.80	498	4.40	797	6.00	1775	6.60	2226	3.30	282	3.60	407	3.50	363	2.60	90
10	3.90	546	4.90	1072	6.00	1775	7.20	2702	3.30	282	3.20	246	3.40	321	2.60	90
11	3.70	452	4.50	850	6.30	1998	5.70	1565	3.20	246	3.20	246	3.00	183	2.50	73
12	4.60	904	4.20	694	6.30	1998	5.20	1249	3.10	213	2.80	132	4.00	595	2.40	59
13	9.10	4515	4.00	595	6.60	2226	4.40	797	3.00	183	3.00	183	3.50	363	2.30	47
14	10.80	6410	3.80	498	6.70	2304	4.10	644	3.00	183	3.50	363	3.00	183	2.20	36
15	7.20	2702	3.80	498	6.60	2226	6.40	2074	2.90	156	3.20	246	2.80	132	2.50	73
16	9.00	4410	3.70	452	6.10	1849	6.00	1775	2.80	132	3.00	183	2.60	90	2.50	73
17	7.40	2872	3.50	363	5.20	1249	5.40	1372	2.80	132	2.90	156	2.60	90	2.50	73
18	5.20	1249	3.40	321	4.90	1072	4.80	1015	2.80	132	5.80	1633	2.50	73	2.40	59
19	4.60	904	3.40	321	5.20	1249	4.40	797	2.80	132	5.40	1372	2.50	73	2.30	47
20	4.20	694	4.10	644	6.60	2226	4.70	959	3.30	282	3.80	498	2.40	59	2.20	36
21	4.10	644	4.80	1015	6.50	2150	7.00	2540	3.20	246	3.60	407	2.40	59	2.20	36
22	7.20	2702	4.40	797	6.30	1998	7.20	2702	3.00	183	3.30	282	2.40	59	2.00	18
23	6.90	2460	4.00	595	5.00	1130	6.80	2382	2.80	132	3.00	183	2.40	59	2.00	18
24	5.50	1435	3.90	546	4.90	1072	6.40	2074	2.80	132	2.80	132	2.40	59	2.00	18
25	5.00	1130	4.00	595	4.60	904	5.80	1633	2.60	90	4.20	694	2.30	47	2.00	18
26	4.90	1072	4.40	797	4.40	797	5.10	1189	2.60	90	3.80	498	2.20	36	2.00	18
27	10.20	5720	4.80	1015	4.00	595	4.60	904	2.60	90	3.80	498	2.20	36	2.00	18
28	8.80	4210	5.40	1372	4.10	644	4.20	694	2.90	156	3.60	407	2.30	47	2.60	90
29	8.70	4110	....	....	4.00	595	4.00	595	2.70	110	3.30	282	2.20	36	3.00	183
30	14.50	10930	....	....	4.50	850	3.90	546	2.70	110	3.20	246	2.20	36	4.00	595
31	14.70	11190	....	....	6.40	2074	....	....	3.00	183	....	...	2.20	36	10.20	5720

Estimated Monthly Discharge of Tygart Valley River at Belington, W. Va.

[Drainage area, 403 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
June, 5–30	7470	282	1854	4.600	4.448
July	16475	363	1711	4.245	4.894
August	5500	132	584	1.449	1.671
September	1072	132	363	0.901	1.005
October	2150	110	559	1.387	1.599
November	3616	246	1294	3.211	3.582
December	4730	321	1360	3.374	3.890
1908					
January	7230	694	1684	4.178	4.817
February	8925	498	2024	5.022	5.416
March	8190	595	1889	4.687	5.404
April	5610	498	1733	4.300	4.798
May	6525	498	2642	6.059	6.986
June	1998	90	388	0.964	1.075
July	2460	47	391	0.970	1.118
August	246	18	84	0.209	0.241
September	36	7	17	0.042	0.047
October	12	7	7	0.017	0.020
November	26	7	18	0.044	0.049
December	183	26	84	0.208	0.240
The year	8925	7	913	2.235	30.211

Estimated Monthly Discharge of Tygart Valley River at Belington, W. Va.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
January	2540	156	557	1.383	1.595
February	2872	363	1177	2.921	3.042
March	3230	407	1152	2.858	3.295
April	5390	407	1661	4.121	4.598
May	1565	183	557	1.382	1.593
June	2960	110	755	1.874	2.091
July	3518	47	217	0.538	0.620
August	2074	26	285	0.707	0.815
September	1703	59	244	0.605	0.675
October	5720	36	559	1.387	1.599
November	2960	132	492	1.220	1.361
December	1310	183	507	1.258	1.450
The year	5720	26	680	1.688	22.734
1910					
January	7110	407	2124	5.271	6.077
February	6180	498	2239	5.556	5.786
March	1372	183	437	1.084	1.250
April	2226	183	558	1.384	1.544
May	3714	246	681	1.689	1.947
June	10485	282	2448	6.074	6.776
July	1435	110	403	1.000	1.153
August	183	18	69	0.171	0.197
September	321	36	113	0.280	0.312
October	132	26	63	0.156	0.180
November	1372	47	148	0.367	0.409
December	3230	183	748	1.856	2.140
The year	10485	18	836	2.074	27.951
1911					
January	11190	452	2826	6.995	8.064
February	2304	321	889	2.200	2.291
March	3230	546	1434	3.549	4.092
April	5610	546	1774	4.391	4.899
May	498	90	320	0.792	0.913
June	1633	59	353	0.874	0.975
July	595	36	139	0.344	0.397
August	5720	26	260	0.643	0.741

WEST FORK RIVER AT ENTERPRISE, W. VA.

This station, situated on the steel highway bridge at Enterprise, Harrison Co., W. Va., 12 miles above the mouth, was established June 2, 1907, by A. H. Horton, for the U. S. Geological Survey.

A standard chain gage, measuring 36.21 feet from marker to bottom of weight, is installed at this station.

The northeast corner of the left abutment, downstream side of bridge, is 33.70 feet above the zero of the gage. A scratch on the west side of the third vertical member, down-stream side of bridge, about 0.44 foot above top of handrail, is 39.80 feet above the zero of the gage.

Measurements are taken from the downstream side of the bridge at ordinary stages, and at low stages, by wading at a point 200 feet above the station.

The bed of the stream is rocky and permanent. Both banks are high and not subject to overflow. There is a range of 32 feet between extreme high and extreme low water.

The gage is read daily by C. M. Tetrick.

The drainage area above the station is 744 square miles.

Discharge Measurements of West Fork River at Enterprise, W. Va.

Date		Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
1907			*Feet*	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
June	2	A. H. Horton...........................	171	825	2.73	4.94	2260
June	8	do	156	558	1.82	3.44	1010
Aug.	10	do	161	718	2.23	4.20	1600
Sept.	13	do	157	500	1.23	3.04	617
1909							
May	18	do	153	292	0.44	1.68	128
Dec.	6	G. L. Parker...........................	151	240	0.25	1.40	60
1910							
Feb.	18	C. T. Bailey...........................	168	1060	3.63	6.35	3850
Feb.	19	do	164	808	2.77	4.90	2240
Feb.	19	do	164	794	2.51	4.83	1990
Feb.	22	do	205	1360	4.21	7.92	5720
Feb.	22	do	207	1570	4.57	8.90	7170
Aug.	17	do	67	48	0.23	0.65	11
Oct.	8a	do	52	37	0.66	0.80	24
Oct.	10a	H. P. Drake...........................	43	26	0.66	0.78	17
1911							
Jan.	15	C. T. Bailey...........................	207	1360	3.62	7.67	4920
Jan.	18	do	158	647	2.04	3.91	1320
Feb.	2	do	160	713	2.45	4.52	1750

a. Wading measurement.

Rating Table for West Fork River at Enterprise, W. Va.

Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge	Gage Height	Discharge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
0.00	0	2.50	395	5.00	2180	7.50	4740	10.00	7670
.10	1	.60	442	.10	2270	.60	4850	.10	7792
.20	2	.70	491	.20	2362	.70	4960	.20	7914
.30	4	.80	542	.30	2456	.80	5070	.30	8036
.40	7	.90	595	.40	2552	.90	5180	40	8158
.50	10	3.00	650	.50	2650	8.00	5290	.50	8280
.60	14	.10	708	.60	2750	.10	5400	.60	8404
.70	18	.20	769	.70	2850	.20	5510	.70	8528
.80	23	.30	832	.80	2950	.30	5625	.80	8652
.90	28	.40	897	.90	3050	.40	5740	.90	8776
1.00	34	.50	965	6.00	3150	.50	5855	11.00	8900
.10	41	.60	1035	.10	3252	.60	5970	.10	9025
.20	49	.70	1107	.20	3356	.70	6085	.20	9150
.30	59	.80	1181	.30	3460	.80	6200	.30	9275
.40	71	.90	1257	.40	3564	.90	6320	.40	9400
.50	86	4.00	1335	.50	3670	9.00	6460	.50	9525
.60	104	.10	1415	.60	3776	.10	6580	.60	9650
.70	125	.20	1497	.70	3882	.20	6700	.70	9775
.80	148	.30	1580	.80	3988	.30	6820	.80	9900
.90	174	.40	1664	.90	4094	.40	6940	.90	10025
2.00	203	.50	1748	7.00	4200	.50	7060	12.00	10150
.10	235	.60	1833	.10	4308	.60	7182	13.00	11450
.20	270	.70	1919	.20	4416	.70	7304	14.00	12750
.30	309	.80	2005	.30	4524	.80	7426	15.00	14100
.40	351	.90	2092	.40	4632	.90	7548	...	....

Note. Above table is furnished by U. S. Geological Survey. It is based on 17 measurements taken 1907–1911. The table is well defined between gage heights 0 and 9.0.

Daily Gage Heights and Discharges of West Fork River at Enterprise, W. Va., for 1907.

Day	June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	1.60	104	2.10	235	2.00	203	2.00	203	3.60	1035	2.60	442
2	4.90	2092	3.00	650	2.00	203	1.90	174	2.00	203	8.40	5740	2.40	351
3	4.80	2005	3.90	1257	2.00	203	1.80	148	2.10	235	6.30	3460	2.30	309
4	3.80	1181	3.60	1035	1.90	174	2.70	491	2.20	270	5.50	2650	2.20	270
5	3.20	769	3.10	708	1.90	174	2.50	395	4.70	1919	5.00	2180	2.10	235
6	3.60	1025	2.00	203	1.90	174	2.30	309	4.00	1335	4.60	1833	2.00	203
7	3.50	965	3.50	965	2.30	309	2.00	203	3.50	965	4.20	1497	2.00	203
8	3.20	769	3.50	965	2.20	270	1.90	174	4.30	1580	4.00	1335	1.90	174
9	4.80	2005	8.40	5740	2.00	203	1.80	148	3.60	1035	3.70	1107	2.10	235
10	4.50	1748	5.00	2180	4.20	1497	1.70	125	3.20	769	3.50	965	2.60	442
11	3.30	832	9.60	7182	3.60	1035	4.50	1748	3.00	650	3.10	708	9.70	7304
12	2.90	595	7.50	4740	2.90	595	6.50	3670	2.80	542	2.80	542	7.50	4740
13	5.10	2270	4.80	2005	2.50	395	4.50	1748	2.60	442	2.40	351	6.00	3150
14	9.40	6940	3.20	769	2.10	235	3.00	650	2.30	309	2.30	309	8.50	5855
15	6.40	3564	3.00	650	2.00	203	2.80	542	2.10	235	2.20	270	9.00	6460
16	4.50	1748	2.90	595	2.00	203	2.50	395	2.10	235	2.20	270	7.00	4200
17	3.50	965	2.50	395	1.90	174	2.10	235	2.00	203	2.10	235	6.30	3460
18	2.90	595	9.50	7060	1.80	148	2.00	203	1.90	174	2.40	351	5.10	2270
19	2.60	442	8.50	5855	2.00	203	3.00	650	1.90	174	3.60	1035	4.00	1335
20	2.40	351	4.90	2092	2.30	309	3.10	708	1.80	148	3.50	965	3.80	1181
21	2.30	309	4.20	1497	2.10	235	2.60	442	1.80	148	3.30	832	3.50	965
22	2.20	270	3.10	708	2.00	203	2.40	351	1.70	125	3.00	650	3.00	650
23	2.00	203	4.60	1833	3.00	650	2.20	270	1.60	104	2.80	542	2.80	542
24	1.80	148	3.80	1181	8.20	5510	2.10	235	1.50	86	10.50	8280	4.80	2005
25	1.60	104	3.50	965	6.80	3988	2.00	203	1.40	71	8.50	5855	4.00	1335
26	1.70	125	3.80	1181	5.60	2750	2.00	203	1.40	71	5.40	2552	3.80	1181
27	1.70	125	3.10	708	4.20	1497	2.00	203	1.50	86	4.50	1748	3.50	965
28	1.70	125	2.70	491	3.50	965	1.80	148	3.60	1035	3.20	769	3.10	708
29	1.80	148	2.30	309	2.60	442	1.90	174	5.40	2552	3.00	650	2.90	595
30	1.60	104	2.20	270	2.40	351	2.00	203	4.50	1748	2.70	491	3.00	650
31	....	...	2.00	203	2.10	235	....	...	3.30	832	....	...	2.60	442

Note. No record for January 1 to June 1, inclusive.

Daily Gage Heights and Discharges of West Fork River at Enterprise, W. Va., for 1908.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Feet*	*Sec.-ft.*
1	2.40	351	3.80	1181	9.00	6460	8.70	6085	2.00	203	2.40	351
2	2.30	309	3.60	1035	14.00	12750	10.40	8158	3.00	650	2.20	270
3	2.20	270	3.40	897	8.00	5290	8.00	5290	2.60	442	2.00	203
4	2.00	203	3.30	832	6.50	3670	6.40	3564	5.00	2180	1.90	174
5	3.00	650	15.00	14100	5.00	2180	4.40	1664	16.40	16010	1.80	148
6	2.80	542	7.70	4960	6.00	3150	3.50	965	11.40	9400	1.70	125
7	2.70	491	5.50	2650	5.40	2552	3.40	897	10.50	8280	1.60	104
8	2.60	442	4.60	1833	5.00	2180	3.20	769	8.20	5510	1.50	86
9	4.20	1497	4.20	1497	13.50	12100	6.80	3988	10.00	7670	1.50	86
10	4.00	1335	4.00	1335	9.60	7182	6.30	3460	9.50	7060	1.40	71
11	4.20	1497	3.70	1107	6.30	3460	6.50	3670	7.10	4308	1.30	59
12	4.60	1833	3.30	832	4.70	1919	5.50	2650	5.20	2362	1.20	49
13	9.90	7548	3.10	708	4.10	1415	4.50	1748	4.00	1335	1.00	34
14	7.60	4850	3.00	650	3.70	1107	4.00	1335	3.20	769	1.00	34
15	5.20	2362	8.30	5625	3.50	965	3.70	1107	3.10	708	3.10	708
16	4.80	2005	8.00	5290	3.30	832	3.30	832	2.80	542	2.60	442
17	4.50	1748	6.40	3564	3.10	708	3.20	769	3.20	769	2.20	270
18	4.10	1415	4.30	1580	3.00	650	3.20	769	3.80	1181	2.00	203
19	3.80	1181	4.00	1335	11.80	9900	3.00	650	5.30	2456	1.90	174
20	3.40	897	6.10	3252	7.60	4850	2.90	595	5.10	2270	1.70	125
21	3.10	708	5.00	2180	5.10	2270	3.10	708	10.60	8404	1.50	86
22	3.00	650	4.50	1748	4.50	1748	2.70	491	5.60	2750	1.40	71
23	2.90	595	4.00	1335	3.90	1257	2.50	395	4.70	1919	1.30	59
24	2.80	542	3.80	1181	3.40	897	2.40	351	4.00	1335	1.20	49
25	2.80	542	3.60	1035	3.10	708	2.30	309	3.70	1107	1.30	59
26	3.50	965	5.70	2850	3.40	897	2.20	270	3.60	1035	1.20	49
27	6.70	3882	5.20	2362	3.20	769	2.20	270	3.50	965	1.10	41
28	5.00	2180	4.80	2005	3.00	650	2.10	235	3.00	650	1.10	41
29	4.60	1833	4.50	1748	6.50	3670	2.00	203	2.80	542	1.90	174
30	4.20	1497	....	....	7.00	4200	1.90	174	2.50	395	1.70	125
31	4.00	1335	....	....	7.00	4200	....	...	2.30	309	....	...

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.60	104	1.90	174	1.00	34	0.80	23	0.80	23	0.80	23
2	1.40	71	1.80	148	0.90	28	0.70	18	0.80	23	0.80	23
3	1.30	59	2.50	395	0.80	23	0.80	23	0.80	23	0.80	23
4	1.20	49	2.00	203	0.70	18	0.80	23	0.80	23	0.80	23
5	1.10	41	1.60	104	0.80	23	0.80	23	0.80	23	0.80	23
6	1.10	41	2.60	442	0.80	23	0.90	28	0.80	23	0.80	23
7	1.10	41	2.10	235	0.80	23	0.80	23	0.80	23	0.80	23
8	1.80	148	2.00	203	0.80	23	0.80	23	0.80	23	0.80	23
9	1.60	104	1.90	174	0.70	18	0.80	23	0.80	23	1.30	59
10	1.40	71	1.80	148	0.60	14	0.70	18	0.80	23	1.10	41
11	1.30	59	1.60	104	0.90	28	0.80	23	0.80	23	1.00	34
12	1.20	49	1.40	71	0.80	23	0.80	23	0.80	23	1.00	34
13	1.10	41	1.30	59	0.70	18	0.80	23	0.80	23	1.10	41
14	1.60	104	1.30	59	0.60	14	0.80	23	0.80	23	1.00	34
15	1.40	71	1.20	49	0.70	18	0.80	23	0.80	23	1.20	49
16	1.50	86	1.10	41	0.70	18	0.80	23	0.80	23	1.10	41
17	1.30	59	1.30	59	0.90	28	0.80	23	0.80	23	1.00	34
18	2.80	542	1.10	41	0.90	28	0.80	23	0.80	23	0.90	28
19	2.00	203	1.00	34	0.90	28	0.80	23	0.80	23	1.20	49
20	2.90	595	1.00	34	0.80	23	0.80	23	0.80	23	1.10	41
21	2.20	270	0.90	28	0.80	23	0.80	23	0.80	23	1.10	41
22	2.00	203	1.00	34	0.90	28	0.80	23	0.80	23	1.20	49
23	1.80	148	1.10	41	0.80	23	0.90	28	0.80	23	1.10	41
24	1.50	86	1.00	34	0.70	18	0.90	28	0.80	23	1.10	41
25	1.40	71	0.90	28	0.60	14	0.90	28	0.80	23	1.00	34
26	1.60	104	0.90	28	0.80	23	0.90	28	0.80	23	1.00	34
27	2.50	395	0.80	23	0.90	28	0.90	28	0.80	23	1.60	104
28	2.30	309	0.80	23	0.80	23	0.90	28	0.80	23	1.30	59
29	2.10	235	0.80	23	0.70	18	0.80	23	0.80	23	1.20	49
30	2.00	203	0.80	23	0.80	23	0.80	23	0.80	23	1.10	41
31	2.00	203	0.70	18	....	..	0.80	23	....	..	1.00	34

Daily Gage Heights and Discharges of West Fork River at Enterprise W. Va., for 1909.

Day	January		February		March		April		May		June		July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	1.30	59	2.90	595	4.80	2005	3.80	1181	8.90	6320	1.90	174	2.60	442	1.60	104	1.30	59	1.20	49	1.60	104	1.50	86
2	1.10	41	2.80	542	4.40	1664	3.40	897	7.00	4200	1.80	148	2.30	309	1.50	86	1.20	49	1.20	49	1.50	86	1.50	86
3	1.60	104	2.60	442	3.50	965	3.00	650	5.20	2362	1.80	148	1.90	174	1.40	71	1.20	49	1.10	41	1.50	86	1.50	86
4	1.80	148	4.80	2005	3.60	1035	3.30	832	4.50	1748	1.80	148	1.30	59	1.30	59	1.20	49	1.00	34	1.50	86	1.50	86
5	1.80	148	4.40	1664	6.20	3356	3.80	1181	3.80	1181	2.40	351	1.50	86	1.20	49	1.20	49	1.00	34	1.60	104	1.50	86
6	1.90	174	4.00	1335	4.20	1497	3.40	897	3.20	769	2.30	309	1.50	86	1.40	71	1.10	41	0.90	28	1.50	86	1.40	71
7	1.80	148	3.90	1257	4.00	1335	3.00	650	2.80	542	2.50	395	1.40	71	1.30	59	1.10	41	0.90	28	1.50	86	1.50	86
8	1.70	125	3.80	1181	3.80	1181	2.70	491	2.50	395	2.40	351	1.30	59	1.20	49	1.10	41	1.00	34	1.40	71	1.60	104
9	1.70	125	4.30	1580	3.70	1107	2.50	395	2.30	309	9.10	6580	1.20	49	1.10	41	1.10	41	0.90	28	1.40	71	1.70	125
10	1.60	104	8.30	5625	3.50	965	2.30	309	2.20	270	4.80	2005	1.10	41	1.00	34	1.90	174	0.90	28	1.50	86	2.00	203
11	1.50	86	6.80	3988	4.40	1664	2.20	270	2.10	235	5.30	2456	1.10	41	0.90	28	4.30	1580	0.90	28	4.30	1580	1.80	148
12	2.30	309	5.20	2362	3.80	1181	2.10	235	2.00	203	4.80	2005	1.00	34	0.80	23	3.20	769	0.90	28	3.30	832	6.40	3564
13	1.80	148	4.80	2005	3.60	1035	2.10	235	1.90	174	4.50	1748	1.50	86	0.80	23	2.20	270	1.20	49	2.50	395	4.60	1833
14	1.70	125	4.30	1580	3.40	897	6.70	3882	1.90	174	3.30	832	1.70	125	0.80	23	1.80	148	1.50	86	2.50	395	3.50	965
15	8.50	5855	3.90	1257	2.90	595	5.60	2750	1.70	125	4.30	1580	1.80	148	1.20	49	1.60	104	1.40	71	2.00	203	3.10	708
16	6.40	3564	10.90	8776	2.60	442	4.40	1664	1.70	125	3.50	965	2.00	203	2.00	203	1.50	86	1.40	71	1.90	174	2.90	595
17	4.80	2005	8.30	5625	4.30	1580	3.30	832	1.70	125	2.80	542	1.90	174	2.50	395	1.40	71	1.40	71	1.80	148	2.80	542
18	6.40	3564	3.80	1181	4.00	1335	3.00	650	1.60	104	7.10	4308	1.70	125	2.00	203	1.30	59	1.50	86	1.70	125	2.70	491
19	4.10	1415	4.30	1580	3.70	1107	2.80	542	1.50	86	6.60	3776	1.80	148	1.90	174	1.20	49	1.40	71	1.60	104	2.60	442
20	3.30	832	4.80	2005	3.20	769	3.30	832	1.50	86	5.50	2650	1.70	125	1.70	125	1.20	49	1.40	71	1.60	104	2.50	395
21	2.80	542	3.80	1181	2.90	595	9.40	6940	1.90	174	3.00	650	1.50	86	3.40	897	1.20	49	1.40	71	1.50	86	2.50	395
22	2.70	491	5.00	2180	4.40	1664	10.30	8036	2.60	442	2.60	442	1.40	71	2.70	491	1.10	41	1.40	71	1.50	86	2.40	351
23	2.40	351	4.30	1580	3.80	1181	9.30	6820	2.20	270	2.70	491	1.30	59	2.30	309	1.10	41	1.60	104	1.50	86	2.40	351
24	4.30	1580	10.00	7670	3.50	965	7.10	4308	2.00	203	2.60	442	1.20	49	1.80	148	1.10	41	7.20	4416	1.50	86	2.40	351
25	3.90	1257	7.90	5180	3.20	769	5.40	2552	1.80	148	2.60	442	1.50	86	1.60	104	1.50	86	6.40	3564	1.60	104	2.40	351
26	3.40	897	5.90	3050	3.00	650	4.60	1833	1.70	125	2.50	395	1.70	125	1.40	71	1.20	49	3.80	1181	1.80	148	2.40	351
27	3.00	650	4.80	2005	2.90	595	4.00	1335	2.00	203	4.20	1497	1.60	104	1.30	59	1.10	41	2.80	542	1.70	125	2.30	309
28	2.80	542	5.30	2456	2.80	542	3.50	965	2.50	395	9.30	6820	1.50	86	1.20	49	1.40	71	2.30	309	1.60	104	2.30	309
29	2.80	542	....	....	4.30	1580	3.00	650	2.30	309	4.40	1664	1.40	71	1.10	41	1.20	49	2.20	270	1.60	104	2.30	309
30	3.30	832	....	....	3.90	1257	2.80	542	2.20	270	3.30	832	1.60	104	1.30	59	1.30	59	1.80	148	1.60	104	2.30	309
31	3.00	650	....	....	3.60	1035	....	...	2.10	235	....	...	1.70	125	1.30	59	....	..	1.80	148	....	...	2.30	309

Daily Gage Heights and Discharges of West Fork River at Enterprise, W. Va., for 1910.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	....	....	3.80	1181	4.90	2092	1.50	86	1.90	174	2.20	270	1.50	86	1.40	71	1.10	41	1.10	41	2.00	203	3.30	832
2	....	....	3.30	832	4.50	1748	1.50	86	1.80	148	2.30	309	1.50	86	1.20	49	1.00	34	1.00	34	2.00	203	2.70	491
3	9.40	6820	4.00	1335	4.10	1415	1.50	86	1.70	125	2.50	395	2.00	203	1.10	41	2.60	442	0.90	28	1.80	148	2.30	309
4	8.80	6200	5.50	2650	3.70	1107	1.60	104	1.60	104	2.40	351	3.50	965	1.10	41	2.40	351	0.90	28	1.70	125	2.30	309
5	5.20	2362	5.40	2552	3.20	769	1.70	125	1.60	104	2.20	270	2.20	270	1.00	34	2.90	595	0.90	28	1.60	104	2.20	270
6	5.00	2180	5.00	2180	3.00	650	1.60	104	1.50	86	6.00	3150	2.00	203	1.00	34	2.60	442	0.90	28	1.40	71	2.80	542
7	11.80	9900	3.70	1107	2.80	542	1.60	104	1.50	86	6.00	3150	3.30	832	0.90	28	2.80	542	0.80	23	1.30	59	2.70	491
8	7.20	4416	3.70	1107	2.60	442	1.60	104	1.50	86	4.60	1833	3.30	832	0.90	28	2.60	442	0.80	23	1.30	59	2.60	442
9	5.00	2180	3.10	708	2.40	351	1.60	104	1.60	104	3.50	965	3.20	769	0.80	23	2.20	270	0.80	23	1.20	49	2.90	595
10	3.60	1035	3.60	1035	2.30	309	1.50	86	1.50	86	3.00	650	2.60	442	1.00	34	1.90	174	0.80	23	1.10	41	3.20	769
11	4.20	1497	4.30	1580	2.20	270	1.40	71	2.40	351	2.60	442	2.00	203	1.00	34	1.80	148	0.80	23	1.30	59	2.20	270
12	3.70	1107	5.00	2180	2.20	270	1.40	71	2.80	542	4.00	1335	2.20	270	0.90	28	2.60	442	0.80	23	1.70	125	3.20	769
13	3.00	650	5.40	2552	2.10	235	1.40	71	7.50	4740	2.90	595	2.60	442	0.90	28	2.40	351	0.80	23	1.70	125	3.10	708
14	9.70	7304	5.80	2950	2.00	203	1.40	71	3.80	1181	2.40	351	4.00	1335	0.80	23	6.50	3670	0.80	23	1.70	125	3.00	650
15	8.00	5290	5.70	2850	2.00	203	1.40	71	3.00	650	2.50	395	3.30	832	0.70	18	5.00	2180	0.80	23	1.70	125	2.80	542
16	6.10	3252	7.80	5070	1.90	174	1.40	71	2.40	351	2.60	442	2.60	442	0.70	18	3.70	1107	0.80	23	1.60	104	2.80	542
17	4.10	1415	9.10	6580	1.90	174	1.40	71	2.30	309	3.70	1107	2.20	270	0.70	18	2.50	395	0.80	23	1.60	104	2.70	491
18	9.60	7182	6.80	3988	1.90	174	1.50	86	2.80	542	3.00	650	2.10	235	0.70	18	2.20	270	0.80	23	1.50	86	2.60	442
19	13.60	12230	4.80	2005	1.80	148	1.50	86	2.40	351	5.00	2180	2.00	203	0.80	23	2.00	203	0.80	23	1.50	86	3.00	650
20	6.90	4094	4.00	1335	1.80	148	1.50	86	2.30	309	4.00	1335	2.00	203	0.80	23	1.90	174	0.80	23	1.30	59	5.60	2750
21	6.70	3882	4.60	1833	1.70	125	1.50	86	2.20	270	3.90	1257	1.80	148	0.70	18	1.70	125	0.80	23	1.30	59	5.00	2180
22	10.40	8158	7.70	4960	1.70	125	1.80	148	2.10	235	2.70	491	1.60	104	0.70	18	1.50	86	1.00	34	1.20	49	4.00	1335
23	6.40	3564	8.60	5970	1.70	125	2.10	235	2.40	351	2.30	309	1.50	86	0.80	23	1.40	71	1.80	148	1.30	59	3.50	965
24	4.60	1833	5.50	2650	1.70	125	2.00	203	2.20	270	2.00	203	1.40	71	1.00	34	1.30	59	1.60	104	1.20	49	7.00	4200
25	4.00	1335	3.90	1257	1.70	125	1.80	148	2.10	235	1.70	125	1.30	59	1.00	34	1.20	49	1.50	86	1.70	125	8.00	5290
26	4.00	1335	3.40	897	1.60	104	2.60	442	3.60	1035	1.60	104	1.30	59	1.00	34	1.10	41	1.70	125	1.60	104	4.70	1919
27	8.20	5510	3.30	832	1.60	104	2.30	309	3.20	769	1.50	86	1.10	41	0.90	28	1.00	34	1.50	86	1.50	86	3.70	1107
28	9.20	6700	3.20	769	1.60	104	2.20	270	2.90	595	1.60	104	1.00	34	0.90	28	1.00	34	1.50	86	1.90	174	3.20	769
29	5.90	3050	....	...	1.50	86	2.10	235	2.60	442	1.50	86	1.30	59	0.80	23	1.90	174	1.60	104	5.80	2950	4.50	1748
30	4.80	2005	....	...	1.50	86	2.00	203	2.40	351	1.50	86	1.30	59	0.70	18	1.50	86	1.50	86	4.70	1919	6.80	3988
31	4.00	1335	....	...	1.50	86	....	...	2.30	309	....	...	1.30	59	0.70	18	....	..	1.40	71	....	...	6.50	3670

Daily Gage Heights and Discharges of West Fork River at Enterprise, W. Va., for 1911.

Day	January		February		March		April		May		June		July		August	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.00	3150	5.20	2362	3.10	708	5.10	2270	2.50	395	1.30	59	1.60	104	0.90	28
2	5.60	2750	4.40	1664	2.90	595	4.50	1748	2.70	491	1.30	59	1.60	104	0.90	28
3	5.00	2180	3.90	1257	2.70	491	4.10	1415	2.50	395	1.20	49	1.50	86	0.80	23
4	6.70	3882	5.30	2456	2.50	395	5.40	2552	2.40	351	1.70	125	1.80	148	0.80	23
5	4.90	2092	4.80	2005	2.40	351	10.50	8280	2.20	270	1.60	104	1.70	125	0.80	23
6	4.70	1919	4.00	1335	2.50	395	7.50	4740	2.10	235	1.50	86	1.60	104	0.90	28
7	3.30	832	4.10	1415	3.30	832	6.30	3460	2.00	203	1.30	59	1.50	86	1.00	34
8	3.00	650	4.00	1335	6.00	1035	5.70	2850	2.00	203	1.30	59	1.80	148	1.00	34
9	4.00	1335	3.80	1181	8.20	5510	7.50	4740	1.80	148	1.30	59	1.70	125	1.00	34
10	3.40	897	3.80	1181	5.60	2750	6.90	4094	1.80	148	1.20	49	1.60	104	0.90	28
11	3.20	769	3.40	897	4.40	1664	4.90	2092	1.80	148	1.20	49	1.40	71	0.90	28
12	3.00	650	3.10	708	3.70	1107	3.90	1257	1.70	125	1.40	71	1.30	59	0.80	23
13	9.80	7426	2.90	595	3.40	897	3.80	1181	1.70	125	1.30	59	1.20	49	0.80	23
14	12.70	11060	2.80	542	4.50	1748	3.70	1107	1.60	104	1.20	49	1.20	49	0.80	23
15	7.60	4850	2.70	491	4.20	1497	9.10	6580	1.60	104	1.10	41	1.10	41	0.90	28
16	8.00	5290	2.50	395	3.90	1257	7.00	4200	1.50	86	1.00	34	1.10	41	0.80	23
17	5.00	2180	2.30	309	3.30	832	4.60	1833	1.50	86	1.00	34	1.00	34	0.80	23
18	4.10	1415	2.30	309	3.10	708	4.10	1415	1.40	71	1.20	49	1.00	34	2.00	203
19	3.50	965	2.20	270	3.80	1181	4.30	1580	1.40	71	3.30	832	1.00	34	1.50	86
20	3.00	650	3.70	1107	4.60	1833	5.60	2750	1.40	71	3.00	650	1.00	34	1.20	49
21	3.00	650	4.70	1919	5.00	2180	4.90	2092	1.40	71	2.40	351	0.90	28	1.10	41
22	7.00	4200	5.80	2950	3.90	1257	4.50	1748	1.70	125	2.20	270	0.90	28	1.10	41
23	5.90	3050	4.40	1664	3.50	965	4.10	1415	1.60	104	1.90	174	0.90	28	1.10	41
24	4.40	1664	3.90	1257	3.20	769	4.50	1748	1.60	104	1.70	125	1.00	34	1.10	41
25	3.80	1181	3.50	965	2.80	542	4.00	1335	1.60	104	1.60	104	1.00	34	1.20	49
26	4.20	1497	3.90	1257	2.60	442	3.40	897	1.60	104	1.90	174	0.90	28	1.60	104
27	7.60	4850	3.80	1181	2.50	395	3.00	650	1.50	86	1.80	148	0.80	23	1.80	148
28	8.30	5625	3.50	965	2.50	395	2.90	595	1.40	71	1.70	125	0.80	23	1.50	86
29	5.80	2950	....	....	2.50	395	2.80	542	1.30	59	1.80	148	0.80	23	1.90	174
30	17.60	17610	....	....	2.40	351	2.70	491	1.30	59	1.70	125	0.80	23	7.70	4960
31	9.70	7304	....	....	5.70	2850	....	....	1.30	59	....	...	0.80	23	10.70	8528

Estimated Monthly Discharge of West Fork River at Enterprise, W. Va.
[Drainage area, 744 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1907					
June 2–30	6940	104	1059	1.423	1.544
July	7182	104	1758	2.363	2.724
August	5510	148	767	1.026	1.184
September	3670	125	512	0.688	0.768
October	2552	71	596	0.801	0.924
November	8280	235	1640	0.220	0.225
December	7304	174	1707	2.294	2.645
1908					
January	7548	203	1489	2.001	2.307
February	14100	650	2438	3.277	3.535
March	12750	650	3374	4.535	5.228
April	8158	174	1746	2.347	2.619
May	16010	203	3017	4.054	4.674
June	708	41	149	0.200	0.223
July	595	41	153	0.206	0.237
August	442	18	99	0.133	0.153
September	34	14	22	0.029	0.032
October	28	18	24	0.032	0.037
November	23	23	23	0.031	0.035
December	104	23	39	0.055	0.063
The year	16010	14	1049	1.408	19.143

Estimated Monthly Discharge of West Fork River at Enterprise, W. Va.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1909					
January	5855	41	884	1.188	1.370
February	8776	442	2567	3.450	3.593
March	3356	442	1179	1.584	1.826
April	8036	235	1778	2.389	2.666
May	6320	86	719	0.966	1.114
June	6820	148	1505	2.023	2.258
July	442	34	114	0.153	0.176
August	897	23	134	0.180	0.207
September	1580	41	143	0.192	0.214
October	4416	28	381	0.512	0.590
November	1580	71	198	0.266	0.297
December	3564	71	464	0.624	0.719
The year	8776	23	839	1.127	14.930
1910					
January 3–31	12230	650	4063	5.461	5.890
February	6580	708	2319	3.117	3.246
March	2092	86	407	0.547	0.631
April	442	71	134	0.180	0.201
May	4740	86	493	0.663	0.764
June	3150	86	767	1.031	1.150
July	1335	34	319	0.429	0.495
August	71	18	29	0.039	0.045
September	3670	34	434	0.583	0.651
October	148	23	47	0.063	0.073
November	2950	41	254	0.341	0.381
December	3988	270	1291	1.735	2.000
The year	12230	18	1182	1.183	15.527
1911					
January	17610	650	3404	4.038	4.656
February	2950	270	1213	1.630	1.697
March	5510	351	1115	1.499	1.728
April	8280	491	2388	3.209	3.580
May	491	59	154	0.207	0.239
June	832	34	144	0.193	0.215
July	148	23	61	0.082	0.095
August	8528	23	484	0.650	0.749

ELK CREEK ABOVE CLARKSBURG, W. VA.

This station, situated at the suspension foot bridge 300 feet above Turkey, and 3 miles above Clarksburg, Harrison Co., W. Va., was established October 11, 1910, by H. P. Drake, for the Flood Commission of Pittsburgh.

A staff gage is bolted to the downstream side of the right abutment of the bridge. The elevation of the zero of the gage is 955.3 feet. The elevation of the downstream corner of the right abutment of the bridge, just above the gage, is 967.2.

Measurements are made from the downstream side of the bridge at ordinary and high stages, and by wading at low stages. The channel is straight for about 500 feet above and 800 feet below the station. The bed of the stream at this point is rocky and permanent. The banks are high and do not overflow. The extreme range of gage heights is about 15 feet.

The gage is read daily by E. H. Smith.

The drainage area above the station is 107 square miles.

A discharge measurement made at this station October 11, 1910, by H. P. Drake, gave a discharge of 8.7 second-feet at gage height 0.48 foot.

Daily Gage Heights, in Feet, of Elk Creek at Clarksburg, W. Va.

Day	1910			1911											
	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1	----	0.50	1.30	1.80	1.90	1.20	1.90	1.00	0.50	0.40	0.00	2.30	1.20	0.80	1.30
2	----	0.60	1.10	2.20	1.80	1.20	1.80	1.30	0.50	0.40	0.00	1.50	3.70	0.80	1.20
3	----	0.60	1.00	2.50	1.60	1.10	1.70	1.10	0.50	0.30	0.00	1.10	3.70	0.70	1.10
4	----	0.60	0.90	2.40	1.60	1.00	2.80	0.90	0.40	0.30	0.10	1.00	2.00	0.70	1.10
5	----	0.60	0.90	1.80	1.60	1.00	3.80	0.90	0.40	0.30	0.10	1.00	1.70	0.70	1.10
6	----	0.60	1.00	1.80	1.50	1.10	2.60	0.80	0.40	0.20	0.10	1.00	1.30	0.70	1.00
7	----	0.60	1.30	1.50	1.60	1.60	2.20	0.80	0.40	0.20	0.10	1.00	1.80	2.30	1.00
8	----	0.50	1.30	1.50	1.50	2.40	2.20	0.70	0.30	0.30	0.10	0.90	3.70	1.60	1.00
9	----	0.50	1.30	1.80	1.50	2.80	3.70	0.70	0.30	0.40	0.00	0.90	2.10	1.40	1.00
10	----	0.50	1.20	1.50	1.50	2.20	2.40	0.70	0.30	0.40	0.00	1.10	1.70	1.20	0.90
11	0.48	0.50	1.10	1.40	1.30	1.80	1.80	0.70	0.30	0.30	0.00	2.40	2.70	1.00	0.90
12	0.40	0.50	1.10	1.30	1.20	1.60	1.50	0.60	0.30	0.30	-0.10	1.80	2.10	1.00	0.90
13	0.40	0.50	1.00	5.00	1.20	1.50	1.50	0.60	0.30	0.20	-0.10	1.50	1.70	1.50	0.90
14	0.40	0.50	0.90	3.70	1.10	1.80	1.40	0.60	0.60	0.20	-0.10	1.40	1.40	1.30	1.00
15	0.40	0.50	1.10	2.90	1.10	1.70	3.30	0.50	0.60	0.20	-0.10	5.00	1.70	1.30	1.90
16	0.40	0.50	1.00	2.70	1.00	1.50	2.10	0.50	0.60	0.10	-0.10	5.20	1.70	1.20	3.40
17	0.40	0.50	0.90	1.90	0.90	1.40	1.80	0.50	0.50	0.10	-0.10	3.00	1.60	1.10	2.40
18	0.40	0.50	0.90	1.60	1.00	1.40	1.50	0.50	1.70	0.10	-0.10	1.80	4.20	2.20	1.80
19	0.40	0.50	1.80	1.50	1.50	1.50	1.40	0.50	1.50	0.00	-0.10	1.40	2.40	2.00	1.40
20	0.40	0.50	1.90	1.40	1.90	2.50	2.00	0.40	1.10	0.00	-0.10	1.20	1.80	1.60	1.30
21	0.50	0.40	1.50	1.40	2.10	1.80	1.90	0.40	0.80	0.00	-0.20	1.10	1.50	1.40	1.80
22	0.70	0.50	1.30	2.80	1.90	1.60	1.80	0.40	0.70	0.00	-0.20	5.30	1.30	1.20	1.70
23	0.70	0.50	1.10	2.30	1.70	1.50	2.40	0.30	0.60	0.00	-0.20	2.10	1.30	1.10	1.60
24	0.60	0.50	3.20	1.80	1.60	1.30	1.90	1.20	0.60	-0.10	-0.20	1.50	1.20	1.30	1.50
25	0.50	0.50	2.10	1.40	1.60	1.20	1.60	0.90	0.50	0.10	-0.10	1.20	1.20	1.90	1.80
26	0.50	0.60	1.60	1.90	1.50	1.10	1.50	0.70	0.50	0.10	0.00	1.00	1.10	1.70	1.70
27	0.50	0.60	1.30	2.50	1.40	1.10	1.40	0.60	0.40	0.10	0.00	0.90	1.00	1.50	3.80
28	0.50	1.40	1.20	2.90	1.30	1.10	1.20	0.50	0.60	0.10	0.00	1.70	1.00	1.40	2.40
29	0.50	2.70	1.40	2.20	---	1.00	1.10	0.40	0.50	0.10	0.10	1.40	0.90	1.40	1.70
30	0.60	1.70	2.50	7.10	---	1.80	1.10	0.40	0.40	0.00	3.00	1.30	0.90	1.40	1.60
31	0.60	---	2.20	2.50	---	2.10	---	0.40	---	0.00	3.90	---	0.80	---	2.50

OHIO RIVER.

OHIO RIVER AT WHEELING, W. VA.

The United States Weather Bureau has made observations of the stage of the Ohio River at Wheeling, W. Va., 90 miles below Pittsburgh, since 1882. In 1905 measurements of the flow were begun by the United States Geological Survey.

A large island divides the river at this point into two channels. This island is almost entirely overflowed during extreme floods. The right channel is straight above and below the station. The current is sluggish for gage heights from 6 to 8 feet. Below 5 feet the velocity is zero, owing to a low rock dam about 3,400 feet below the measuring section. In high and medium stages the dam is submerged. The right bank is high, clean, and does not overflow. The left bank overflows in extreme high water. The bed of the stream is rocky and sandy, and is permanent.

The left channel is straight above and below the station. The current is swift. The left bank is high, clean, and does not overflow. The right bank overflows in extreme high water. The bed of the stream is composed of gravel, and is permanent.

Discharge measurements in the right channel are made from the downstream side of a steel trolley and highway bridge 50 feet above the water surface. Discharge measurements in the left channel are made from the downstream side of a steel trolley and highway bridge about 100 feet above the water surface.

The "Government" gage, from which continuous records are furnished by the United States Weather Bureau, consists of sandstone blocks set in the riprap of the left bank of the left channel about 150 feet below the Pennsylvania depot. One foot verti-

cal equals 5 feet on the incline. The extreme range of gage heights is about 53 feet.

The bench mark for the Weather Bureau gage is the high-water mark of February 7, 1884, cut in the stone bottom of the ogee on top of the water table on the southwest corner of the custom-house, corner of Sixteenth and Market streets; elevation 53.1 feet above the zero of the gage. On June 1, 1905, the elevations of the foot marks of this gage were obtained, the 6.00 mark being assumed to be correct. Thus each foot mark in the stone flagging gage is a bench mark. Elevations below 5.00 feet were not determined.

Other bench marks established for the gage are as follows: (1) The highest point on the corner of the upstream side of the right abutment of the bridge over the right channel, marked by black paint; elevation 52.60 feet above zero of the gage; (2) the southeast corner of the southwest stone support of the crossing watchman's tower, about 100 feet beyond the west end of the bridge; elevation, 48.96 feet above zero of the gage. The elevation of the zero of the gage is 610.29.

The drainage area above the station is 23,800 square miles.

Dam No. 13, 6 miles below Wheeling, backs water about 7 feet above low water at the station. This dam was begun March 1, 1906, and was first raised October 1, 1909.

Discharge Measurements of Ohio River at Wheeling, W. Va.

Date	Hydrographer	Width	Area of Section	Mean Velocity	Gage Height	Discharge
		Feet	*Sq. ft.*	*Ft. per sec.*	*Feet*	*Sec.-ft.*
a	....				8.50	36260
1892						
Oct. 10-13b	U. S. Engineers........................	c642	c3472	c0.88	1.10	3050
1905						
Mar. 14	E. C. Murphy........................	1362	19920	4.10	14.35	81740
Mar. 14	do	1352	19300	4.01	13.94	77440
Mar. 15	do	1326	17410	3.80	12.37	66280
Mar. 17	do	1285	15040	3.45	10.43	51850
Mar. 20	do	1457	38890	5.89	28.20	229200
Mar. 20	do	1461	42750	6.13	30.80	261900
Mar. 21	do	1489	54780	6.23	38.90	341100
Mar. 21	do	1489	57360	6.18	40.70	354400
Mar. 22	do	1486	59580	6.07	42.05	361600
Mar. 22	do	1486	60510	6.05	42.50	365700
Mar. 23	do	1488	58830	5.73	41.60	336900
Mar. 23	do	1486	56790	5.60	40.30	318100
Mar. 24	do	1482	49250	5.20	35.20	255800
Mar. 24	do	1482	45550	4.99	32.70	227300
Mar. 25	do	1457	37560	4.95	27.20	186100
Mar. 25	do	1457	35050	4.80	25.50	168100
Mar. 27	do	1452	30830	4.83	22.44	149100
April 13	A. H. Horton........................	1344	18700	3.65	13.06	68380
April 19	do	1259	11710	2.46	7.51	28760
April 21	do	1266	11490	2.44	7.35	27990
June 1	R. H. Bolster........................	1192	9054	1.62	5.20	14640
Aug. 25	E. C. Murphy........................	1201	9799	1.84	5.78	18040
Aug. 28	do	1231	12310	2.56	7.78	31500
Nov. 1	do	1212	10270	1.93	6.20	19800
1906						
May 22	U. S. Geological Survey..................	1220	9880	1.76	5.70	17400

a. From Weather Bureau Report, made prior to 1893.

b. Computed from 3 measurements at Davis Island dam, Pa., and 2 measurements at Marietta, Ohio, made by U.S. Engineers in October, 1892.

c. Left channel (Wheeling side) only.

Rating table for Ohio River at Wheeling will be found on page 314.

Daily Gage Heights and Discharges of Ohio River at Wheeling, W. Va., for 1904.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.30	20600	9.50	43750	15.60	91360	14.70	84100	18.20	112900	10.30	49780
2	6.00	18810	8.60	37000	26.30	186455	28.90	212290	17.10	103660	13.90	77710
3	5.30	15190	8.10	33250	25.50	178705	33.90	264555	15.40	89740	17.00	102830
4	4.90	13500	7.50	28810	36.80	296380	28.60	209260	13.30	72970	16.00	94600
5	5.50	16150	6.50	21870	38.50	315505	22.00	146040	11.60	59720	13.60	75340
6	9.70	45250	6.10	19390	29.00	213300	16.60	99520	10.10	48260	11.20	56640
7	12.20	64360	5.50	16150	22.70	152395	14.00	78500	9.30	42250	9.90	46750
8	12.70	68260	9.60	44500	28.40	207250	12.30	65140	8.10	33250	10.00	47500
9	12.30	65140	23.90	163500	36.30	290830	11.40	58180	7.90	31760	9.30	42250
10	11.60	59720	26.30	186455	29.30	216360	11.30	57410	7.30	27350	8.90	39250
11	11.50	58950	20.60	133580	22.30	148755	11.90	62030	6.90	24530	8.50	36250
12	11.30	57410	16.40	97880	18.30	113750	13.10	71390	6.60	22520	7.90	31760
13	10.90	54340	13.20	72180	15.60	91360	12.80	69040	6.20	19990	7.40	28080
14	10.80	53580	11.20	56640	13.60	75340	11.90	62030	5.90	18250	6.70	23180
15	10.70	52820	9.70	45250	11.90	62030	11.20	56640	5.60	16650	5.90	18250
16	10.20	49020	8.70	37750	10.90	54340	10.40	50540	5.90	18250	5.60	16650
17	10.10	48260	7.90	31760	10.10	48260	9.80	46000	6.20	19990	5.20	14740
18	10.10	48260	5.70	17170	9.50	43750	9.30	42250	6.90	24530	5.50	16150
19	9.90	46750	6.00	18810	9.30	42250	9.30	42250	7.10	25920	5.20	14740
20	9.60	44500	5.00	13900	9.90	46750	9.00	40000	8.50	36250	4.90	13500
21	11.10	55870	4.00	10220	10.90	54340	8.60	37000	14.90	85700	4.90	13500
22	20.60	133580	5.20	14740	12.50	66700	7.40	28080	14.40	81700	5.90	18250
23	34.20	267800	7.60	29540	14.20	80100	7.80	31020	12.90	69820	6.30	20600
24	43.90	378610	11.80	61260	17.90	110360	7.30	27350	11.80	61260	6.00	18810
25	41.00	344300	12.90	69820	24.60	170100	7.30	27350	10.90	54340	6.30	20600
26	31.50	239055	11.90	62030	22.60	151480	7.70	30280	11.30	57410	6.20	19990
27	22.50	150570	9.80	46000	21.90	145140	8.60	37000	11.60	59720	5.60	16650
28	19.80	126590	8.20	34000	24.20	166320	11.90	62030	12.40	65920	5.00	13900
29	13.00	70600	9.50	43750	23.00	155140	17.80	109520	14.00	78500	5.90	18250
30	10.80	53580	.....	......	19.00	119700	19.20	121420	12.30	65140	7.40	28080
31	10.00	47500	.....	......	15.60	91360	.....	......	10.60	52060	.....	......

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	5.90	18250	3.80	9570	3.40	8340	3.60	8940	3.90	9890	1.60	3940
2	6.40	21230	3.90	9890	3.00	7200	3.50	8640	3.60	8940	1.60	3940
3	6.80	23850	3.70	9250	3.00	7200	3.10	7480	3.30	8050	1.60	3940
4	6.40	21230	3.60	8940	2.90	6930	3.10	7480	2.90	6930	1.60	3940
5	6.20	19990	3.90	9890	2.60	6150	3.10	7480	2.70	6400	1.60	3940
6	6.90	24530	3.70	9250	2.80	6660	3.10	7480	2.70	6400	2.00	4760
7	8.00	32500	3.10	7480	2.50	5900	2.90	6930	2.60	6150	2.50	5900
8	11.60	59720	2.90	6930	2.40	5660	2.80	6660	2.50	5900	2.30	5430
9	14.20	80100	2.90	6930	2.80	6660	2.80	6660	2.30	5430	2.00	4760
10	11.30	57410	2.70	6400	2.80	6660	2.80	6660	2.20	5200	1.50	3750
11	10.90	54340	2.60	6150	2.50	5900	2.80	6660	2.20	5200	1.40	3570
12	13.90	77710	2.20	5200	2.30	5430	2.70	6400	2.20	5200	2.30	5430
13	13.10	71390	2.20	5200	2.20	5200	2.70	6400	2.20	5200	1.90	4550
14	11.40	58180	2.20	5200	2.20	5200	2.60	6150	2.20	5200	2.50	5900
15	9.90	46750	2.40	5660	2.50	5900	2.60	6150	2.10	4980	1.90	4550
16	9.10	40750	2.40	5660	2.20	5200	2.60	6150	2.20	5200	1.90	4550
17	7.90	31760	2.30	5430	2.10	4980	3.60	8940	2.10	4980	2.00	4760
18	6.90	24530	2.40	5660	1.90	4550	3.70	9250	2.10	4980	1.40	3570
19	6.20	19990	1.60	3940	1.90	4550	3.50	8640	2.00	4760	1.60	3940
20	5.20	14740	2.90	6930	1.60	3940	3.10	7480	1.90	4550	1.50	3750
21	4.70	12710	2.50	5900	1.90	4550	2.90	6930	1.90	4550	1.40	3570
22	4.90	13500	2.60	6150	1.80	4340	2.90	6930	1.90	4550	1.90	4550
23	4.50	11960	2.70	6400	1.60	3940	2.60	6150	1.90	4550	1.90	4550
24	4.10	10560	3.10	7480	1.50	3750	2.80	6660	1.80	4340	2.00	4760
25	4.20	10900	3.90	9890	1.40	3570	2.80	6660	1.80	4340	2.50	5900
26	4.70	12710	4.10	10560	1.40	3570	2.60	6150	1.70	4140	3.40	8340
27	4.30	11250	5.10	14310	1.40	3570	4.20	10900	1.30	3390	11.30	57410
28	3.90	9890	4.10	10560	1.30	3390	4.90	13500	1.50	3750	12.90	69820
29	4.20	10900	3.90	9890	1.30	3390	4.20	10900	1.50	3750	15.00	86500
30	3.90	9890	3.70	9250	2.10	4980	3.90	9890	1.80	4340	16.40	97880
31	3.60	8940	3.60	8940	....	....	3.90	9890	....	....	12.60	67480

Daily Gage Heights and Discharges of Ohio River at Wheeling, W. Va., for 1905.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	10.60	52060	4.40	11600	17.70	108680	14.00	78500	8.80	38500	5.30	15190
2	9.40	43000	4.40	11600	17.70	108680	12.40	65920	8.20	34000	5.00	13900
3	8.80	38500	5.90	18250	16.70	100345	10.90	54340	7.50	28810	5.60	16650
4	8.00	32500	6.80	23850	15.30	88930	9.80	46000	6.80	23850	6.60	22520
5	8.50	36250	7.60	29540	14.30	80900	8.90	39250	6.50	21870	5.90	18250
6	8.80	38500	7.60	29540	14.00	78500	8.20	34000	6.20	19990	5.30	15190
7	7.50	28810	6.90	24530	14.40	81700	7.60	29540	6.00	18810	5.00	13900
8	6.80	23850	6.90	24530	13.40	73760	7.90	31760	7.00	25220	7.60	29540
9	6.10	19390	6.90	24530	17.90	110360	7.90	31760	6.90	24530	9.40	43000
10	6.00	18810	8.90	39250	25.70	180635	8.50	36250	6.90	24530	9.00	40000
11	6.00	18810	9.10	40750	27.70	200245	8.90	39250	7.00	25220	8.00	32500
12	5.90	18250	17.60	107840	26.30	186455	11.60	59720	7.80	31020	8.30	34750
13	6.90	24530	14.70	84100	20.30	130950	13.10	71390	9.00	40000	8.30	34750
14	17.30	105330	15.30	88930	14.90	85700	11.90	62030	13.50	74550	8.80	38500
15	17.40	106165	15.30	88930	13.00	70600	10.60	52060	12.60	67480	7.90	31760
16	13.70	76130	15.10	87310	11.30	57410	8.40	35500	14.20	80100	7.30	27350
17	11.30	57410	14.30	80900	10.50	51300	8.10	33250	14.40	81700	7.10	25920
18	9.30	42250	a13.00	70600	10.90	54340	7.90	31760	12.10	63580	7.90	31760
19	8.00	32500	a11.60	59720	14.90	85700	7.60	29540	10.50	51300	7.90	31760
20	7.30	27350	a10.30	49780	28.20	205240	7.30	27350	9.20	41500	9.50	43750
21	7.20	26630	a11.10	55870	39.70	329250	7.30	27350	8.40	35500	9.50	43750
22	7.20	26630	a11.80	61260	b42.30	359585	8.90	39250	7.90	31760	10.90	54340
23	7.00	25220	a11.40	58180	41.80	353680	11.80	61260	7.00	25220	13.70	76130
24	6.60	22520	a11.00	55100	34.00	265630	14.30	80900	6.60	22520	16.30	97060
25	6.50	21870	a10.50	51300	26.20	185480	13.40	73760	6.00	18810	14.30	80900
26	6.00	18810	13.80	76920	23.20	156985	11.50	58950	5.90	18250	12.30	65140
27	5.20	14740	15.40	89740	22.60	151480	9.90	46750	5.40	15660	11.00	55100
28	5.00	13900	16.60	99520	21.20	138880	9.10	40750	4.90	13500	9.60	44500
29	3.90	9890	.....	......	19.90	127460	9.40	43000	5.10	14310	9.00	40000
30	3.10	7480	.....	......	17.90	110360	9.70	45250	5.20	14740	7.90	31760
31	3.90	9890	.....	......	15.90	93790	.....	.....	5.60	16650	.....	.....

Day	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.60	22520	13.40	73760	4.90	13500	2.90	6930	6.50	21870	22.00	146040
2	6.00	18810	11.40	58180	4.50	11960	2.80	6660	6.20	19990	20.90	136220
3	5.90	18250	8.90	39250	4.00	10220	2.80	6660	6.20	19990	19.30	122280
4	6.00	18810	7.30	27350	3.70	9250	3.00	7200	6.60	22520	c27.10	194290
5	6.60	22520	6.10	19390	3.10	7480	3.30	8050	6.50	21870	30.60	229690
6	6.90	24530	5.60	16650	3.40	8340	4.00	10220	6.10	19390	23.90	163500
7	7.90	31760	5.20	14740	3.30	8050	4.60	12330	6.20	19990	17.50	107000
8	8.80	38500	4.90	13500	3.10	7480	3.90	9890	6.70	23180	13.70	76130
9	9.50	43750	4.50	11960	2.90	6930	3.40	8340	7.90	31760	11.60	59720
10	9.90	46750	4.60	12330	2.90	6930	3.00	7200	8.60	37000	10.60	52060
11	8.40	35500	4.80	13100	2.80	6660	2.90	6930	8.70	37750	9.90	46750
12	7.70	30280	4.60	12330	3.40	8340	2.90	6930	8.00	32500	9.30	42250
13	7.90	31760	4.70	12710	10.70	52820	3.10	7480	7.90	31760	8.30	34750
14	8.30	34750	5.00	13900	10.30	49780	4.10	10560	7.30	27350	7.90	31760
15	9.60	44500	6.10	19390	8.70	37750	5.90	18250	6.90	24530	7.30	27350
16	9.90	46750	8.10	33250	7.10	25920	6.10	19390	6.60	22520	6.90	24530
17	8.60	37000	11.40	58180	6.20	19990	6.20	19990	6.60	22520	6.30	20600
18	6.90	24530	11.30	57410	6.10	19390	5.70	17170	6.60	22520	6.00	18810
19	6.90	24530	9.30	42250	6.00	18810	5.10	14310	6.40	21230	5.90	18250
20	6.00	18810	7.90	31760	5.70	17170	6.80	23850	6.60	22520	5.90	18250
21	6.10	19390	6.50	21870	5.70	17170	9.00	40000	6.40	21230	6.60	22520
22	9.00	40000	5.70	17170	6.50	21870	15.90	93760	6.10	19390	8.60	37000
23	8.00	32500	5.50	16150	5.90	18250	13.10	71390	5.90	18250	13.60	75340
24	6.60	22520	5.20	14740	5.10	14310	10.50	51300	5.50	16150	15.90	93790
25	5.90	18250	5.90	18250	4.70	12710	9.00	40000	5.10	14310	15.30	88930
26	6.80	23850	6.10	19390	4.20	10900	8.60	37000	5.00	13900	13.60	75340
27	6.60	22520	7.10	25920	3.80	9570	8.10	33250	5.00	13900	11.30	57410
28	5.00	13900	8.10	33250	3.40	8340	8.20	34000	5.00	13900	10.30	49780
29	5.00	13900	6.90	24530	3.10	7480	8.50	36250	6.00	18810	9.30	42250
30	4.30	11250	5.70	17170	2.90	6930	7.90	31760	12.60	67480	9.60	44500
31	5.80	17700	5.00	13900	.....	.....	6.90	24530	.....	.....	13.60	75340

a. Frozen. Gage heights estimated. b. Max. 42.7 = 364330 sec.-ft. c. Max. 31.6 = 240100 sec.-ft.

Daily Gage Heights and Discharges of Ohio River at Wheeling, W. Va., for 1906.

Day	January		February		March		April		May		June	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	14.90	85700	8.60	37000	7.20	26630	26.60	189380	8.90	39250	5.90	18250
2	13.00	70600	8.30	34750	6.80	23850	26.30	186455	7.60	29540	5.70	17170
3	11.30	57410	7.80	31020	6.10	19390	21.80	144240	7.50	28810	5.30	15190
4	12.00	62800	6.90	24530	6.50	21870	21.30	139770	7.80	31020	5.30	15190
5	15.60	91360	6.30	20600	8.00	32500	14.70	84100	8.10	33250	7.20	26630
6	19.30	122280	5.60	16650	10.90	54340	13.00	70600	9.00	40000	7.00	25220
7	16.10	95420	5.40	15660	10.90	54340	13.90	77710	9.60	44500	6.40	21230
8	13.30	72970	5.10	14310	9.90	46750	15.70	92170	9.00	40000	6.60	22520
9	11.00	55100	4.80	13100	8.90	39250	14.10	79300	8.60	37000	16.40	97880
10	9.40	43000	4.20	10900	8.60	37000	13.50	74550	7.90	31760	12.00	62800
11	8.20	34000	4.30	11250	8.30	34750	16.30	97060	7.50	28810	9.00	40000
12	7.00	25220	4.50	11960	8.00	32500	19.30	122280	7.30	27350	7.70	30280
13	7.00	25220	4.80	13100	7.80	31020	18.00	111200	7.20	26630	6.60	22520
14	7.10	25920	4.70	12710	7.70	30280	15.90	93790	6.90	24530	6.10	19390
15	8.20	34000	4.70	12710	7.80	31020	14.00	78500	6.60	22520	5.40	15660
16	10.00	47500	4.80	13100	7.80	31020	13.70	76130	6.40	21230	4.90	13500
17	12.30	65140	4.80	13100	13.30	72970	17.00	102830	6.10	19390	4.60	12330
18	11.90	62030	4.80	13100	13.70	76130	16.40	97880	6.30	20600	4.50	11960
19	11.90	62030	4.90	13500	10.80	53580	13.60	75340	6.20	19990	4.50	11960
20	11.90	62030	4.90	13500	9.80	46000	11.80	61260	5.90	18250	4.60	12330
21	11.90	62030	5.10	14310	12.30	65140	10.40	50540	5.90	18250	4.10	10560
22	11.10	55870	5.30	15190	14.30	80900	9.30	42250	5.80	17700	4.40	11600
23	11.40	58180	5.60	16650	11.90	62030	8.90	39250	5.20	14740	5.80	17700
24	16.20	96240	6.90	24530	9.90	46750	8.50	36250	4.90	13500	7.60	29540
25	24.30	167260	8.00	32500	8.40	35500	8.30	34750	4.40	11600	7.80	31020
26	21.30	139770	8.60	37000	7.90	31760	8.30	34750	4.70	12710	6.50	21870
27	16.90	102000	8.30	34750	10.00	47500	8.30	34750	4.30	11250	5.60	16650
28	13.50	74550	8.10	33250	17.60	107840	16.30	97060	4.50	11960	5.10	14310
29	12.30	65140	....	.....	24.40	168205	15.00	86500	4.40	11600	4.80	13100
30	10.30	49780	....	.....	25.60	179670	10.90	54340	5.10	14310	5.00	13900
31	9.90	46750	....	.....	23.90	163500	.....	......	5.90	18250	.....	.....

Day	July		August		September		October		November		December	
	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge	Gage Ht.	Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	4.90	13500	4.30	11250	4.70	12710	2.90	6930	8.00	32500	6.30	20600
2	4.40	11600	4.00	10220	4.00	10220	3.90	9890	8.20	34000	6.30	20600
3	4.00	10220	3.90	9890	3.90	9890	4.10	10560	8.00	32500	6.00	18810
4	3.40	8340	3.30	8050	3.90	9890	4.50	11960	7.50	28810	6.00	18810
5	3.90	9890	2.80	6660	3.90	9890	5.00	13900	6.90	24530	6.50	21870
6	3.60	8940	3.40	8340	4.00	10220	5.10	14310	6.40	21230	6.30	20600
7	3.10	7480	3.10	7480	4.10	10560	5.00	13900	5.90	18250	9.00	40000
8	3.10	7480	3.50	8640	4.10	10560	6.00	18810	5.70	17170	14.80	84900
9	3.40	8340	6.30	20600	3.60	8940	7.00	25220	5.50	16150	17.40	106165
10	3.50	8640	10.50	51300	3.30	8050	8.30	34750	5.10	14310	15.20	88120
11	2.90	6930	13.70	76130	2.90	6930	8.80	38500	4.90	13500	14.00	78500
12	2.50	5900	15.30	88930	2.80	6660	8.30	34750	4.50	11960	18.70	117150
13	2.40	5660	13.00	70600	2.70	6400	7.90	31760	4.80	13100	22.90	154225
14	2.30	5430	9.90	46750	2.90	6930	7.90	31760	4.60	12330	18.90	118850
15	2.10	4980	7.90	31760	3.00	7200	7.80	31020	4.80	13100	14.90	85700
16	2.50	5900	6.90	24530	3.00	7200	7.20	26630	5.30	15190	13.50	74550
17	3.20	7760	6.30	20600	3.10	7480	7.00	25220	5.90	18250	14.30	80900
18	5.20	14740	5.60	16650	3.20	7760	6.90	24530	5.90	18250	16.50	98700
19	6.60	22520	5.60	16650	3.00	7200	6.30	20600	7.10	25920	19.30	122280
20	5.90	18250	5.60	16650	2.90	6930	6.20	19990	9.30	42250	19.80	126590
21	4.60	12330	9.10	40750	3.20	7760	7.20	26630	12.90	69820	15.30	88930
22	3.90	9890	12.60	67480	4.50	11960	7.90	31760	18.00	111200	12.30	65140
23	4.20	10900	10.00	47500	4.00	10220	9.00	40000	16.60	99520	10.90	54340
24	5.80	17700	9.60	44500	3.70	9250	8.20	34000	13.90	77710	10.10	48260
25	4.20	10900	8.10	33250	3.20	7760	7.30	27350	11.60	59720	9.20	41500
26	4.50	11960	7.60	29540	3.40	8340	6.90	24530	9.90	46750	7.80	31020
27	4.20	10900	6.90	24530	3.10	7480	6.30	20600	8.60	37000	7.00	25220
28	3.90	9890	5.90	18250	3.00	7200	6.90	24530	7.90	31760	6.90	24530
29	3.90	9890	6.00	18810	3.00	7200	7.20	26630	7.00	25220	7.20	26630
30	5.50	16150	5.40	15660	2.90	6930	7.10	25920	6.90	24530	10.80	53580
31	4.80	13100	5.00	13900	....	.....	7.60	29540	.....	......	15.60	91360

Daily Gage Heights and Discharges of Ohio River at Wheeling, W. Va., for 1907.

Day	January Gage Ht.	January Discharge	February Gage Ht.	February Discharge	March Gage Ht.	March Discharge	April Gage Ht.	April Discharge	May Gage Ht.	May Discharge	June Gage Ht.	June Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	17.00	102830	7.90	31760	8.10	33250	14.90	85700	12.00	62800	8.70	37750
2	19.80	126590	8.50	36250	8.30	34750	12.30	65140	10.90	54340	8.30	34750
3	18.90	118850	10.50	51300	9.20	41500	10.90	54340	10.00	47500	8.30	34750
4	16.30	97060	16.20	96240	10.40	50540	9.80	46000	9.60	44500	12.50	66700
5	16.60	99520	15.20	88120	11.40	58180	9.00	40000	9.30	42250	12.90	69820
6	18.20	112900	12.60	67480	10.30	49780	8.60	37000	9.90	46750	12.40	65920
7	18.80	118000	9.20	41500	9.60	44500	8.00	32500	11.90	62030	12.30	65140
8	16.70	100345	8.50	36250	9.20	41500	8.00	32500	11.20	56640	13.30	72970
9	16.60	99520	7.60	29540	8.80	38500	8.10	33250	11.30	57410	12.30	65140
10	20.20	130075	7.20	26630	8.50	36250	8.20	34000	11.70	60490	11.60	59720
11	24.00	164440	7.30	27350	9.30	42250	8.00	32500	15.30	88930	11.30	57410
12	21.00	137100	7.30	27350	9.50	43750	8.20	34000	13.30	72970	10.90	54340
13	19.90	127460	7.10	25920	17.50	107000	8.10	33250	11.90	62030	10.90	54340
14	26.30	186455	7.30	27350	37.90	308705	8.10	33250	10.30	49780	12.90	69820
15	28.00	203230	7.00	25220	a47.80	425020	8.60	37000	9.10	40750	16.30	97060
16	31.40	238010	7.90	31760	48.90	438110	8.90	39250	8.80	38500	19.00	119700
17	28.90	212290	8.70	37750	38.00	309830	8.90	39250	8.30	34750	15.90	93790
18	27.20	195280	8.70	37750	27.90	202235	8.80	38500	8.20	34000	12.70	68260
19	31.60	240100	8.50	36250	22.80	153310	9.60	44500	8.80	38500	9.90	46750
20	36.10	288610	8.70	37750	25.10	174860	9.50	43750	8.40	35500	8.50	36250
21	35.90	286400	9.30	42250	31.80	242200	9.10	40750	8.30	34750	7.70	30280
22	29.30	216360	9.90	46750	29.30	216360	9.00	40000	11.30	57410	6.90	24530
23	21.90	145140	9.20	41500	23.00	155140	8.60	37000	10.20	49020	6.90	24530
24	16.90	102000	8.70	37750	17.90	110360	9.40	43000	8.90	39250	7.00	25220
25	13.10	71390	7.90	31760	15.80	92980	10.90	54340	8.00	32500	6.70	23180
26	10.90	54340	7.00	25220	13.90	77710	15.30	88930	8.30	34750	6.90	24530
27	9.90	46750	7.30	27350	13.00	70600	18.30	113750	8.30	34750	6.60	22520
28	9.70	45250	8.20	34000	16.50	98700	18.00	111200	9.10	40750	6.30	20600
29	8.30	34750	.....	.....	18.90	118850	16.50	98700	9.90	46750	6.60	22520
30	7.90	31760	.....	.....	19.70	125725	15.30	88930	11.40	58180	6.60	22520
31	7.60	29540	.....	.....	18.00	111200	.....	......	10.00	47500	.....	......

Day	July Gage Ht.	July Discharge	August Gage Ht.	August Discharge	September Gage Ht.	September Discharge	October Gage Ht.	October Discharge	November Gage Ht.	November Discharge	December Gage Ht.	December Discharge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	6.50	21870	6.00	18810	3.50	8640	4.30	11250	9.20	41500	7.00	25220
2	6.30	20600	5.50	16150	2.90	6930	4.40	11600	7.90	31760	7.10	25920
3	7.90	31760	5.40	15660	3.20	7760	4.30	11250	8.10	33250	6.50	21870
4	9.60	44500	5.00	13900	3.60	8940	4.30	11250	9.10	40750	6.20	19990
5	9.00	40000	5.40	15660	4.20	10900	4.80	13100	15.10	87310	6.00	18810
6	7.90	31760	5.40	15660	5.50	16150	6.40	21230	15.50	90550	5.60	16650
7	6.80	23850	5.10	14310	5.50	16150	8.90	39250	14.00	78500	5.20	14740
8	6.00	18810	5.40	15660	4.60	12330	9.80	46000	13.80	76920	4.60	12330
9	5.00	13900	5.90	18250	4.10	10560	8.80	38500	16.40	97880	4.10	10560
10	5.30	15190	5.40	15660	4.20	10900	8.50	36250	14.60	83300	4.20	10900
11	5.60	16650	5.80	17700	5.30	15190	9.70	45250	13.10	71390	5.60	16650
12	7.00	25220	5.10	14310	5.00	13900	9.80	46000	11.90	62030	10.00	47500
13	9.60	44500	5.30	15190	9.30	42250	8.00	32500	10.90	54340	15.00	86500
14	10.20	49020	5.10	14310	8.30	34750	7.20	26630	9.60	44500	13.00	70600
15	9.60	44500	4.60	12330	7.00	25220	6.60	22520	8.30	34750	11.10	55870
16	9.10	40750	3.90	9890	6.00	18810	6.00	18810	7.30	27350	11.50	58950
17	9.00	40000	3.30	8050	4.90	13500	6.60	22520	6.80	23850	13.00	70600
18	8.00	32500	3.00	7200	5.10	14310	6.60	22520	6.20	19990	11.80	61260
19	15.60	91360	2.80	6660	4.10	10560	5.80	17700	5.70	17170	10.50	51300
20	18.00	111200	2.80	6660	5.30	15190	5.40	15660	5.80	17700	9.30	42250
21	14.00	78500	3.00	7200	5.80	17700	5.40	15660	5.90	18250	8.20	34000
22	10.00	47500	2.90	6930	5.90	18250	4.60	12330	6.20	19990	7.50	28810
23	7.90	31760	2.90	6930	5.80	17700	4.00	10220	6.20	19990	7.80	31020
24	6.90	24530	2.50	5900	5.50	16150	4.00	10220	6.20	19990	12.00	62800
25	9.30	42250	2.90	6930	5.00	13900	4.00	10220	6.60	22520	24.20	166320
26	9.90	46750	8.60	37000	4.90	13500	4.00	10220	8.40	35500	b25.90	182565
27	10.40	50540	10.00	47500	4.70	12710	4.00	10220	9.70	45250	21.60	142445
28	12.90	69820	8.30	34750	4.30	11250	4.00	10220	8.70	37750	17.50	107000
29	10.50	51300	6.50	21870	4.90	13500	4.30	11250	7.60	29540	14.00	78500
30	8.20	34000	5.10	14310	3.90	9890	7.10	25920	7.10	25920	14.20	80100
31	7.00	25220	3.90	9890	....	.....	9.70	45250	.....	.....	15.80	92980

a. Max. 9 P. M. 50.1 = 452390 sec.-ft.   b. Max. 26.0 = 183530 sec.-ft.

Daily Gage Heights and Discharges of Ohio River at Wheeling, W. Va., for 1908.

Day	January Gage Ht.	January Dis-charge	February Gage Ht.	February Dis-charge	March Gage Ht.	March Dis-charge	April Gage Ht.	April Dis-charge	May Gage Ht.	May Dis-charge	June Gage Ht.	June Dis-charge	July Gage Ht.	July Dis-charge	August Gage Ht.	August Dis-charge	September Gage Ht.	September Dis-charge	October Gage Ht.	October Dis-charge	November Gage Ht.	November Dis-charge	December Gage Ht.	December Dis-charge
	Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1	15.00	86500	9.00	40000	9.20	41500	16.90	102000	8.60	37000	10.90	54340	3.90	9890	4.30	11250	1.00	2890	0.00	1600	0.50	2180	0.90	2740
2	14.20	80100	7.60	29540	14.90	85700	16.90	102000	10.60	52060	10.60	52060	3.00	7200	4.30	11250	0.90	2740	0.00	1600	0.50	2180	0.80	2590
3	12.90	69820	6.20	19990	26.10	184505	16.90	102000	11.90	62030	10.00	47500	3.00	7200	3.40	8340	0.90	2740	0.00	1600	0.50	2180	0.80	2590
4	11.70	60490	6.50	21870	32.00	244300	15.70	92170	12.60	67480	9.30	42250	2.60	6150	2.90	6930	0.70	2450	0.00	1600	0.50	2180	0.80	2590
5	10.50	51300	6.60	22520	28.00	203230	14.00	78500	13.70	76130	8.00	32500	4.70	12710	3.40	8340	0.50	2180	0.00	1600	0.50	2180	0.80	2590
6	8.70	37750	7.20	26630	21.90	145140	12.00	62800	15.10	87310	7.30	27350	4.90	13500	3.90	9890	0.40	2050	0.00	1600	0.50	2180	0.80	2590
7	8.90	39250	6.70	23180	24.30	167260	10.90	54340	21.80	144240	7.80	31020	6.30	20600	4.40	11600	0.40	2050	0.00	1600	0.40	2050	0.80	2590
8	8.20	34000	11.60	59720	31.60	240100	10.60	52060	21.60	142445	6.60	22520	5.70	17170	3.90	9890	0.30	1930	0.00	1600	0.40	2050	0.90	2740
9	7.70	30280	9.30	42250	31.60	240100	12.80	69040	26.00	183530	6.10	19390	4.50	11960	3.70	9250	0.30	1930	0.00	1600	0.40	2050	1.90	4550
10	6.90	24530	8.00	32500	28.70	210270	16.40	97880	25.50	178705	5.70	17170	4.70	12710	3.30	8050	0.30	1930	0.40	2050	0.40	2050	1.10	3050
11	6.60	22520	7.00	25220	27.20	195280	18.60	116300	20.80	135340	4.90	13500	4.20	10900	3.90	9890	0.30	1930	0.50	2180	0.50	2180	0.80	2590
12	6.50	21870	6.90	24530	22.00	146040	18.00	111200	19.00	119700	4.50	11960	3.50	8640	4.00	10220	0.70	2450	0.40	2050	0.50	2180	0.80	2590
13	6.90	24530	7.90	31760	18.50	115450	18.50	115450	16.60	99520	4.90	13500	2.80	6660	3.20	7760	0.40	2050	0.40	2050	0.50	2180	0.80	2590
14	15.80	92980	10.80	53580	17.70	108680	16.30	97060	13.60	75340	4.40	11600	3.30	8050	2.90	6930	0.40	2050	0.20	1820	0.50	2180	1.30	3390
15	20.50	132700	19.80	126590	19.20	121420	13.30	72970	11.30	57410	3.90	9890	3.00	7200	2.90	6930	0.40	2050	0.20	1820	0.60	2310	1.60	3940
16	17.00	102830	34.00	265630	21.20	138880	11.60	59720	10.20	49020	4.30	11250	3.40	8340	2.10	4980	0.30	1930	0.20	1820	0.50	2180	1.60	3940
17	13.50	74550	a 42.60	363140	22.70	152395	11.90	62030	11.00	55100	4.40	11600	4.40	11600	2.20	5200	0.30	1930	0.40	2050	0.80	2590	1.80	4340
18	11.50	58950	39.20	323500	22.30	148755	12.90	69820	17.00	102830	4.20	10900	3.60	8940	2.50	5900	0.30	1930	0.20	1820	0.80	2590	2.30	5430
19	10.10	48260	29.30	216360	26.70	190360	12.60	67480	18.30	113750	6.00	18810	3.90	9890	2.60	6150	0.40	2050	0.30	1930	0.80	2590	2.90	6930
20	9.10	40750	20.90	136220	b 36.70	295270	13.90	77710	15.60	91360	6.10	19390	3.70	9250	2.20	5200	0.40	2050	0.40	2050	0.80	2590	5.60	16650
21	8.30	34750	16.40	97880	38.40	314370	15.30	88930	18.20	112900	4.90	13500	4.30	11250	1.90	4550	0.20	1820	0.50	2180	0.80	2590	7.10	25920
22	7.80	31020	14.40	81700	29.50	218400	14.90	85700	20.10	129200	4.90	13500	4.30	11250	1.60	3940	0.20	1820	0.50	2180	0.80	2590	7.00	25220
23	7.50	28810	12.40	65920	20.90	136220	13.40	73760	19.70	125725	4.80	13100	4.90	13500	1.90	4550	0.20	1820	0.40	2050	0.80	2590	5.50	16150
24	7.50	28810	11.00	55100	16.60	99520	11.90	62030	17.00	102830	4.00	10220	6.80	23850	2.90	6930	0.20	1820	0.40	2050	0.80	2590	4.50	11960
25	8.10	33250	9.90	46750	14.40	81700	10.60	52060	14.50	82500	4.90	13500	6.90	24530	2.60	6150	0.20	1820	0.50	2180	0.80	2590	4.30	11250
26	8.20	34000	9.10	40750	13.00	70600	9.70	45250	11.90	62030	4.40	11600	6.90	24530	2.00	4760	0.20	1820	0.60	2310	0.80	2590	3.10	7480
27	8.30	34750	9.90	46750	12.60	67480	8.90	39250	10.40	50540	3.90	9890	8.00	32500	1.90	4550	0.10	1710	0.60	2310	0.80	2590	3.20	7760
28	8.30	34750	11.00	55100	11.70	60490	8.60	37000	9.60	44500	4.50	11960	7.70	30280	1.90	4550	0.10	1710	0.60	2310	0.80	2590	3.40	8340
29	11.30	57410	10.60	52060	11.70	60490	8.30	34750	10.30	49780	4.60	12330	8.20	34000	1.60	3940	0.10	1710	0.60	2310	0.90	2740	3.40	8340
30	11.80	61260	.....	......	13.50	74550	7.90	31760	11.30	57410	3.90	9890	7.20	26630	1.40	3570	0.00	1600	0.50	2180	0.90	2740	3.60	8940
31	10.50	51300	.....	......	16.80	101170	.....	......	10.00	47500	.....	.....	5.90	18250	1.60	3940	....	....	0.50	2180	....	....	3.40	8340

a. Max. 10 P.M. 42.8 = 365520 sec.-ft. b. Max. 7.40 P.M. 39.6 = 328100 sec.-ft.

Estimated Monthly Discharge of Ohio River at Wheeling, W. Va.

[Drainage area, 23,800 square miles.]

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1904					
January	378610	13500	89320	3.750	4.323
February	186455	10220	51412	2.160	2.330
March	315505	42250	135028	5.670	6.537
April	264555	27350	77607	3.260	3.637
May	112900	16650	50978	2.140	2.467
June	102830	13500	34486	1.450	1.618
July	80100	8940	29747	1.250	1.441
August	14310	3940	7706	0.320	0.369
September	8340	3390	5242	0.220	0.245
October	13500	6150	7780	0.330	0.380
November	9890	3390	5375	0.230	0.257
December	97880	3570	16117	0.680	0.784
The year	378610	3390	42567	1.790	24.388
1905					
January	106165	7480	33483	1.410	1.626
February	107840	11600	55142	2.320	2.416
March	364330	51300	142355	5.980	6.894
April	80900	27350	46880	1.970	2.198
May	81700	13500	33661	1.410	1.626
June	97060	13900	38321	1.610	1.796
July	46750	11250	27432	1.150	1.326
August	73760	11960	25927	1.090	1.257
September	52820	6660	15810	0.660	0.736
October	93790	6660	23278	0.980	1.130
November	67480	13900	24003	1.010	1.127
December	240100	18250	72014	3.030	3.493
The year	364330	6660	44859	1.880	25.625
1906					
January	167260	25220	68300	2.870	3.309
February	37000	10900	19812	0.850	0.864
March	179670	19390	57548	2.420	2.790
April	189380	34750	85500	3.590	4.005
May	44500	11250	23881	1.000	1.153
June	97880	10560	23075	0.970	1.082
July	22520	4980	10520	0.440	0.507
August	88930	6660	29221	1.230	1.418
September	12710	6400	8524	0.360	0.402
October	40000	6930	24403	1.030	1.187
November	111200	11960	33551	1.410	1.573
December	154225	18810	66078	2.780	3.205
The year	189380	4980	37534	1.580	21.495
1907					
January	288610	29540	134269	5.640	6.502
February	96240	25220	39504	1.660	1.729
March	452390	33250	130763	5.490	6.329
April	113750	32500	51743	2.170	2.421
May	88930	32500	48582	2.040	2.352
June	119700	20600	50360	2.120	2.365
July	111200	13900	40649	1.710	1.971
August	47500	5900	15201	0.640	0.738
September	42250	6930	15250	0.640	0.714
October	46000	10220	21985	0.920	1.061
November	97880	17170	43650	1.830	2.042
December	183530	10560	56291	2.370	2.732
The year	452390	5900	54021	2.270	30.956

Estimated Monthly Discharge of Ohio River at Wheeling, W. Va.—(Continued.)

Month	Discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
1908					
January	132700	21870	50454	2.120	2.444
February	365520	19990	83681	3.520	3.796
March	328100	41500	150310	6.320	7.286
April	116300	31760	73779	3.100	3.459
May	183530	37000	90168	3.790	4.369
June	54340	9890	19933	0.840	0.937
July	34000	6150	14811	0.620	0.715
August	11600	3570	6948	0.290	0.334
September	2890	1600	2032	0.085	0.094
October	2310	1600	1945	0.082	0.094
November	2740	2050	2368	0.099	0.111
December	25920	2590	7120	0.300	0.346
The year	365520	1600	41962	1.763	23.985

Rating Table for Ohio River at Wheeling, W. Va.

Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge	Gage Height	Dis-charge
Feet	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Feet*	*Sec.-ft.*
1.00	2890	3.90	9890	6.80	23850	11.40	58180	20.50	132700
.10	3050	4.00	10220	.90	24530	.60	59720	21.00	137100
.20	3220	.10	10560	7.00	25220	.80	61260	.50	141550
.30	3390	.20	10900	.10	25920	12.00	62800	22.00	146040
.40	3570	.30	11250	.20	26630	.20	64360	.50	150570
.50	3750	.40	11600	.30	27350	.40	65920	23.00	155140
.60	3940	.50	11960	.40	28080	.60	67480	.50	159760
.70	4140	.60	12330	.50	28810	.80	69040	24.00	164440
.80	4340	.70	12710	.60	29540	13.00	70600	.50	169150
90	4550	.80	13100	.70	30280	.20	72180	25.00	173900
2.00	4760	.90	13500	.80	31020	.40	73760	26.00	183530
10	4980	5.00	13900	.90	31760	.60	75340	27.00	193300
.20	5200	.10	14310	8.00	32500	.80	76920	28.00	203230
.30	5430	.20	14740	.20	34000	14.00	78500	29.00	213300
.40	5660	.30	15190	.40	35500	.20	80100	30.00	223500
50	5900	.40	15660	.60	37000	.40	81700	31.00	233830
.60	6150	.50	16150	.80	38500	.60	83300	32.00	244300
70	6400	.60	16650	9.00	40000	.80	84900	33.00	254900
80	6660	.70	17170	.20	41500	15.00	86500	34.00	265630
.90	6930	.80	17700	.40	43000	.50	90550	35.00	276500
3.00	7200	.90	18250	.60	44500	16.00	94600	36.00	287500
.10	7480	6.00	18810	.80	46000	.50	98700	37.00	298600
.20	7760	.10	19390	10.00	47500	17.00	102830	38.00	309830
.30	8050	.20	19990	.20	49020	.50	107000	39.00	321200
.40	8340	.30	20600	.40	50540	18.00	111200	40.00	332700
.50	8640	.40	21230	.60	52060	.50	115450	41.00	344300
.60	8940	.50	21870	.80	53580	19.00	119700	42.00	356030
.70	9250	.60	22520	11.00	55100	.50	124000	43.00	367900
.80	9570	.70	23180	.20	56640	20.00	128330	44.00	379800

The above table is furnished by the U. S. Geological Survey. It is applicable only for open-channel conditions. It is based on 24 discharge measurements made during 1905, one prior to 1893, and one low-water measurement computed from five measurements made by the United States Army engineers above and below Wheeling in 1892.

It is well defined above gage height 5 feet. Below 5 feet it is based on one measurement at 1.1 feet, computed from the army engineers' measurements, and the extension of the area and velocity curves, and can be considered accurate within a few per cent.

RELATION BETWEEN RAINFALL AND RUN-OFF.

The tables of estimated monthly discharge in the preceding pages give, for the respective drainage areas, the depth in inches of the annual run-off. By selecting the proper rainfall stations from the precipitation records in Appendix No. 2, it is possible to determine the average rainfall over the drainage areas for the corresponding years, and thus to obtain the percentage of rainfall running off. This average rainfall has been obtained by straight averages of all records used, except in the case of the Wheeling station, where averages weighted according to the respective tributary areas have been employed.

The following tables contain these figures for the various stations, insofar as the available data enable estimates. When discharge data are not at hand, these percentages of run-off are a useful guide in figuring the approximate annual discharge from rainfall records. They also serve as the basis for interesting comparisons of the run-off from various drainage basins.

TABLE No. 49.

RELATION BETWEEN ANNUAL RAINFALL AND RUN-OFF.

Allegheny Basin.

Station	Year	Average rainfall on drainage basin (Inches)	Run-off Depth in inches	Run-off Per cent of rainfall
Allegheny River at Aspinwall, Pa.	1903	43.77	31.24	71.4
Drainage area, 11580 sq. miles.	1904	41.84	33.16	79.1
	1905	45.42	23.72	52.2
	1906	39.23	26.68	68.0
	1907	43.04	26.39	61.2
Mean	....	42.66	28.24	66.4
Allegheny River at Kittanning, Pa.	1906	41.90	21.10	50.4
Drainage area, 9010 sq. miles.	1907	41.94	25.90	61.7
	1908	36.95	26.70	72.4
	1909	39.69	23.10	63.0
	1910	39.99	22.40	57.0
Mean	....	40.09	23.84	60.6
Allegheny River at Red House, N. Y.	1905	44.97	23.40	52.0
Drainage area, 1640 sq. miles.	1906	39.12	21.70	55.5
	1907	37.26	22.80	56.5
	1908	40.37	25.30	62.7
	1909	43.05	24.50	56.8
	1910	38.15	22.90	60.0
Mean	....	40.49	23.43	57.3
Kiskiminetas River at Avonmore, Pa.	1908	43.24	30.40	70.3
Drainage area, 1720 sq. miles.	1909	40.28	20.00	49.6
	1910	40.44	26.90	66.5
Mean	....	41.24	25.77	62.1
Black Lick Creek at Black Lick, Pa.	1907	48.08	27.10	56.3
Drainage area, 386 sq. miles.	1908	42.27	28.00	66.2
	1909	41.82	23.40	56.3
	1910	39.11	27.50	70.3
Mean	....	42.82	26.50	62.9

TABLE No. 49—(Continued.)

RELATION BETWEEN ANNUAL RAINFALL AND RUN-OFF.

Allegheny Basin.

Station	Year	Average rainfall on drainage basin (Inches)	Run-off Depth in inches	Run-off Per cent of rainfall
*Clarion River at Clarion, Pa. Drainage area, 910 sq. miles.	1894	42.03	28.40	67.5
	1902	42.85	33.70	78.5
	1903	46.24	40.90	88.5
	1904	42.57	36.20	85.0
	1905	48.37	31.50	65.2
	1906	38.92	27.60	71.0
	1907	41.73	39.40	94.3
	1908	39.40	39.20	99.4
	1909	41.94	31.70	75.5
	1910	40.67	25.40	62.3
Mean	....	42.45	33.40	78.7
French Creek at Carlton, Pa. Drainage area, 1070 sq. miles.	1909	37.62	23.40	59.5
	1910	38.78	30.20	78.0
Mean	....	38.20	26.80	68.7
Oil Creek at Rouseville, Pa. Drainage area, 302 sq. miles.	1910	38.84	25.73	67.0
Tionesta Creek at Nebraska, Pa. Drainage area, 451 sq. miles.	1910	38.94	26.88	69.2
Brokenstraw Creek at Youngsville, Pa. Drainage area, 290 sq. miles.	1910	37.75	32.00	84.8
Conewango Creek at Frewsburg, N. Y. Drainage area, 550 sq. miles.	1910	37.26	28.67	77.0
Kinzua Creek at Dewdrop, Pa. Drainage area, 171 sq. miles.	1910	40.38	29.00	71.8

Monongahela Basin.

Station	Year	Average rainfall on drainage basin (Inches)	Run-off Depth in inches	Run-off Per cent of rainfall
**Youghiogheny River at Confluence, Pa. Drainage area, 435 sq. miles.	1899	43.56	34.60	79.4
	1900	38.82	27.50	71.4
	1901	42.81	32.40	75.8
	1902	50.91	38.40	74.0
	1903	48.00	37.10	77.3
	1906	50.35	32.30	64.2
	1907	61.51	53.10	86.2
	1908	46.98	33.20	70.6
	1909	50.20	24.40	48.5
	1910	39.30	27.20	69.2
Mean	....	47.24	34.02	71.7
Youghiogheny River at Friendsville, Md. Drainage area, 294 sq. miles.	1899	44.59	39.50	88.7
	1900	39.82	29.90	75.2
	1901	42.42	38.10	89.8
	1902	51.68	41.60	80.4
	1903	49.48	40.30	81.7
	1904	37.02	26.40	71.3
Mean	....	42.50	35.97	81.2

*Records of Clarion River discharge incomplete 1895–1901, inclusive.
**Records of discharge incomplete for 1904 and 1905.

TABLE No. 49—(Continued.)

RELATION BETWEEN ANNUAL RAINFALL AND RUN-OFF.

Monongahela Basin.

Station	Year	Average rainfall on drainage basin (Inches)	Run-off Depth in inches	Run-off Per cent of rainfall
Laurel Hill Creek at Confluence, Pa.	1906	49.93	28.80	57.6
Drainage area, 126 sq. miles.	1907	56.52	47.10	84.8
	1908	43.88	30.40	69.3
	1909	41.52	26.20	63.0
Mean	....	47.96	33.10	68.7
Casselman River at Confluence, Pa.	1906	49.21	25.80	52.4
Drainage area, 448 sq. miles.	1907	56.55	43.30	76.5
	1908	45.57	27.30	59.9
	1909	44.43	20.30	45.7
	1910	40.26	22.40	55.6
Mean	....	47.20	27.82	58.0
†Cheat River at Uneva, W. Va.	1903	46.49	28.00	60.2
Drainage area, 1380 sq. miles.	1904	37.56	21.20	56.5
	1905	50.27	27.60	54.8
	1909	49.86	28.20	56.5
Mean	....	46.04	26.25	57.0
Tygart Valley River at Fetterman, W. Va.	1908	49.68	25.30	50.8
Drainage area, 1327 sq. miles.	1909	54.09	22.50	41.6
	1910	46.94	22.80	48.6
Mean	....	50.27	23.53	47.0
‡West Fork River at Enterprise, W. Va.	1908	40.65	19.10	47.0
Drainage area, 744 sq. miles.	1909	45.11	14.90	33.0
	1910	38.47	15.50	40.3
Mean	....	41.41	16.50	40.0

Ohio River.

Ohio River at Wheeling, W. Va.	1904	39.55	24.39	61.0
Drainage area, 23800 sq. miles.	1905	45.58	25.63	56.2
	1906	41.16	21.50	52.2
	1907	47.61	30.96	65.0
	1908	39.84	23.99	60.0
Mean	....	42.75	25.29	58.9

†Records of Cheat River discharge incomplete, 1906–1908, inclusive.
‡Computations on West Fork River are probably in error, owing to the discharge curve being only provisional.

From the above table it is seen that the maximum recorded percentage of run-off on the Allegheny Basin was 99.4 per cent, on the Clarion River, in 1908. The minimum percentage of run-off was 49.6 per cent, on the Kiskiminetas River, in 1909. The maximum on the Monongahela Basin was 89.8 per cent, on the Youghiogheny River, at Friendsville, Md., in 1901, and the minimum was 33.0 per cent, on the West Fork River, in 1909. It is thought that the figures for the West Fork River may be somewhat in error,

as the discharge curve for the gaging station at Enterprise is as yet only provisional. The next lowest percentage of run-off on the Monongahela Basin was 41.6 per cent, on Tygart Valley River, at Fetterman, W. Va., in 1909.

There is no record of the daily discharge of the Ohio River at Pittsburgh, so that the figures for the percentage run-off from the drainage area above Pittsburgh cannot be given. The figures for the Wheeling station, however, serve as an index of what may be expected.

MAXIMUM AND MINIMUM DISCHARGE.

The following tables show the maximum and minimum stage and discharge at the gaging stations where records are available.

TABLE No. 50.

MAXIMUM AND MINIMUM DISCHARGE OF ALLEGHENY RIVER AND TRIBUTARIES.

Stream	Maximum				Minimum			Drainage Area	Remarks
	Date	Gage Height	Discharge		Gage Height	Discharge			
		Feet	*Sec.-ft.*	*Sec.-ft. per sq. mi.*	*Feet*	*Sec.-ft.*	*Sec.-ft. per sq. mi.*	*Square miles*	
Allegheny									
Red House	1910	13.65	41000	25.00	2.60	100	0.06	1640	
Kittanning	1905	28.80	240250	26.70	1.30	775	0.086	9010	
Pittsburgh	1891	.....	300000	26.00	....	950	0.082	11580	
Black Lick									
Black Lick	1907	13.20	19620	50.80	1.90	6	0.016	386	
Mouth	....	.....	21000	.....	....	7	.....	414	
Brokenstraw									
Mouth	....	.....	14350	45.00	....	45	0.14	319	Estimated.
Clarion									
Clarion	1905	16.00	39300	43.10	-1.20	50	0.055	910	
Mouth	....	.....	52400	.....	....	...	.....	1213	
Conewango									
Mouth	....	.....	33000	37.00	....	145	0.16	892	Estimated.
Crooked									
Mouth	....	.....	14000	48.80	0.65	1*	0.0035	287	Estimated.
Cussewago									
Mouth	....	.....	5000	47.60	....	3	0.029	105	Maximum estimated.
French									
Carlton	1888	16.50	48700	45.50	0.75	50	0.047	1070	
Mouth	....	.....	56330	.....	....	58	.....	1238	
Kinzua									
Dewdrop	1907	11.20	7660	47.30	0.10	13	0.08	162	
Mouth	....	.....	8000	.....	....	...	.....	169	
Kiskiminetas									
Avonmore	1859	.....	80000	46.50	1.60	65	0.038	1720	
Loyalhanna									
Mouth	....	.....	14180	51.00	1.20	10	0.036	278	Estimated.
Mahoning									
Furnace Bridge ..	....	.....	18750	45.50	....	20	0.049	412	Maximum
Mouth	....	.....	19000	.....	....	...	.....	417	estimated.
North Branch French									
Kimmeytown	....	13.90	12000	56.50	0.40	20	0.094	212	
Oil									
Rouseville	....	.....	15000	49.50	0.50	39	0.13	302	Maximum estimated.
Red Bank									
St. Charles	1902	15.00	25000	46.20	....	10	0.019	540	Estimated.
Mouth	....	.....	27000	.....	....	11	.....	585	
Sugar									
Wyattville	....	.....	8000	50.20	0.90	9	0.057	159	Maximum estimated.
Tionesta									
Nebraska	1902	.....	20600	45.60	0.60	38	0.084	451	
Mouth	....	.....	21750	.....	....	40	.....	477	

*In 1910 Crooked Creek had a discharge under 5 second-feet for 15 days, while at the end of August, the discharge fell to 1 second-foot.

TABLE No. 51.

MAXIMUM AND MINIMUM DISCHARGE OF MONONGAHELA RIVER AND TRIBUTARIES.

Stream	Maximum				Minimum			Drainage Area	Remarks
	Date	Gage Height	Discharge		Gage Height	Discharge			
		Feet	Sec.-ft.	Sec.-ft. per sq. mi.	Feet	Sec.-ft.	Sec.-ft. per sq. mi.	Square miles	
Casselman Confluence	1907	18.10	20000	44.60	1.30	9	0.02	448	
Cheat Ice's Ferry	1880	.....	59850	43.30	1.60	135	0.098	1380	
Laurel Hill Confluence	1907	17.00	5800	45.30	....	0	.....	128	
Monongahela Lock No. 4	1888	42.00	207000	38.10	....	...	.....	5430	
Turtle E. Pittsburgh ...	1904	10.70	9375	64.50	0.10	10	0.069	145	
Tygart Valley Fetterman	1888	29.00	56600	43.60	2.30	12	0.009	1296	
Belington	1888	19.60	17700	43.80	1.80	7	0.02	404	
West Fork Enterprise	1888	33.00	40000	53.80	0.60	14	0.019	744	
Youghiogheny Confluence	1907	16.80	24000	55.50	1.20	23	0.053	432	

UNITED STATES WEATHER BUREAU STATIONS.

For the purpose of predicting floods, the United States Weather Bureau maintains a number of gages on the main rivers and their principal tributaries. These gages are read daily at 8 A.M. and the readings telegraphed to the office of the Local Forecaster at Pittsburgh. The following table contains a list of these stations, together with the date of their establishment, their distance from Pittsburgh, and the highest and lowest recorded stages at each.

TABLE No. 52.

UNITED STATES WEATHER BUREAU GAGES.

Stream	Station	Distance from Pgh. (miles)	Elevation of Zero (feet)	Flood Stage (feet)	Highest Stage (feet)	Lowest Stage (feet)	Date of Establishment
Allegheny.....	Warren, Pa.............	192	1137.0	14	17.4	-1.1	Nov., 1884
Allegheny.....	Franklin, Pa............	126	957.3	15	....	...	Apr., 1905
Clarion........	Clarion, Pa..............	118	1052.0	10	16.2	-1.4	1884
Allegheny.....	Parker, Pa..............	85	849.4	20	28.0	-0.9	Jan., 1885
Conemaugh....	Johnstown, Pa..........	109	1147.8	7	21.0	0.2	1884
Kiskiminetas..	Saltsburg, Pa...........	56	828.3	6	22.1	-1.8	Nov., 1901
Allegheny.....	Freeport, Pa............	29	741.0	20	....	0.0	Apr., 1873
Allegheny.....	Springdale, Pa..........	17	714.0	27	33.0	...	Jan., 1905
Allegheny.....	Herr Id., Pa............	1.7	697.0	22	36.9	1.3	
Allegheny.... } Monongahela }	Pittsburgh, Pa..........	0	696.8	22	35.5	-1.3*	May, 1873
Youghiogheny.	W. Newton, Pa.........	34	746.5	23	28.2	-0.3	Nov., 1890
Monongahela..	Lock No. 4, Pa..........	41	719.0	28	42.0	3.2	1885
Monongahela..	Greensboro, Pa.	85	768.0	18	39.0	4.3	July, 1888
Youghiogheny.	Confluence, Pa..........	85	1324.0	10	18.6	-0.8	1883
Monongahela..	Fairmont, W. Va.......	127	844.8	25	37.0	-0.8	Jan., 1892
Cheat..........	Rowlesburg, W. Va.....	135	1375.3	14	22.0	-1.4	1884
West Fork....	Weston, W. Va.........	195	891.0	18	21.0	-4.0	Nov., 1884
Ohio...........	Davis Id., Pa...........	5	690.6	25	24.2	0.7	Oct., 1885

*Note.—The minimum is for open-channel conditions. Davis Island dam, completed in 1885, gives slackwater stage of about 6.0 feet at Pittsburgh gage.

APPENDIX No. 4.

SURVEYS AND MAPS.

City Surveys—Surveys of Reservoir Projects—Spirit Leveling by Flood Commission—Bench Marks—Checks—Cost of Surveys, Mapping and Investigations.

The surveys found necessary by the Engineering Committee of the Flood Commission, in connection with its investigations and studies, may be divided into two classes: City Surveys and Surveys of Reservoir Projects.

CITY SURVEYS.

City Department and Government Surveys. Near the beginning of the work, when the investigations relative to flood damage were in progress, the City Surveys Department coöperated with the Commission by preparing a map of comparatively large scale. This map, consisting of 19 sheets, was quickly made, using existing data and a limited amount of field work, and therefore showed little beyond the approximate location of street lines, river lines and the top of the bank.

These maps were used temporarily, but it was soon realized that the investigation demanded complete and accurate maps, which would include all important details. The U. S. Engineer harbor line maps, of the local part of the rivers, while considered absolutely reliable, extend little beyond the river bank, and do not indicate the conformation of the land surface or the bed of the rivers.

Flood Commission Surveys. The City Surveys of the Flood Commission were begun July 8, 1909, and completed November 6 of the same year. The work was accomplished with about 12 men, divided into two or more parties, as the case demanded.

Transit lines, with distances carefully measured, were extended along the river banks, and on some of the most important streets, in such manner that accurate control was obtained of the general situation. The remaining thoroughfares were measured and closed in with the stations of the transit lines. Levels were run over all streets and alleys, for developing the crossing places of contours, and the flood lines were located during this work. The carefully determined and monumented system of triangulation of the government was used as a base for all transit lines.

Soundings, for development of the river bed, were taken at close intervals, on ranges about 200 feet apart, carefully lined in between flags placed at marks opposite each other, on the transit lines. All the soundings were located with a transit by angles turned from the shore survey lines. The soundings were taken from a skiff with a graduated pole 12 feet long, except in the deeper parts of the rivers, where a line and sounding lead were used, the length of the line being tested at regular intervals during the day. A small gasoline launch, loaned by a city department, was used in directing the work and for transporting the sounding party and shore parties between various parts of the river.

As the sounding operations progressed, topography was taken along the river banks, the work being projected from the stations of the previously run transit lines, along each side of the river, from which were obtained the location of contours, top of bank and edge of water, while the elevations were determined from the water surface of the slackwater pools, frequent gage readings during the day being obtained. So far as the

rivers were concerned, the surveys were made under favorable circumstances, as the level of the water surface varied but little; in fact at no time did the gage indicate a height of over a few inches above normal.

The work in the city, however, was frequently conducted under discouraging circumstances, as the surveys, for a considerable par of the 4,960 acres covered, extended through districts congested with numerous mills, buildings and railroad tracks. Atmospheric conditions affected progress to a greater or less extent, as fog and smoke, particularly the latter, many times retarded work until late in the morning. The great activity of traffic also embarrassed operations, particularly the precise level work, and some long lines had to be run four times to obtain the desired degree of accuracy. The length of river covered by these surveys amounts to about 20 miles.

Flood Commission Maps. The map of the City Survey, which consists of 13 sheets, has been constructed on a scale of 1 inch to 160 feet. This scale, while rather unusual, enabled getting the full width of the rivers and flooded area on the sheets without making them of inconvenient size. The sheets are of uniform size, each 34 inches by 52 inches. The coördinate system of the U. S. Engineer harbor line survey was used, but the base was changed from Davis Island dam to the Court House tower.

This map, which shows all important features, has been carefully prepared, and is considered accurate, especially for the portion covering the river proper and the immediate banks. Practically all the sheets were constructed from Flood Commission surveys, as described. Some parts have been taken from data furnished by corporations. The maps have been lithographed on a scale of approximately 1 inch to 200 feet. An index map of small scale, showing extent of survey, industrial district, and profiles of rivers, accompanies the report.

SURVEYS OF RESERVOIR PROJECTS.

Government Surveys. The U. S. Geological Survey, up to the present time, has completed topographic maps covering about 60 per cent of the combined area of the Allegheny and Monongahela drainage basins. About 42 per cent of the Allegheny and 90 per cent of the Monongahela Basin has been completed.

Flood Commission Surveys. Complete topographic surveys of 25 projects and reconnoissance surveys of 23 others, were made between November 9, 1909, and September 19, 1910. To these may be added the examination of 24 streams where projects were not considered.

As a considerable part of the total area surveyed is wooded, in places very heavily, it was thought better to make the surveys during the winter months, when the trees were bare of foliage. It unfortunately happened, however, that toward the end of December, 1909, the winter developed into conditions of unusual severity, with the snow covering most of the Allegheny Basin to considerable depth until the end of February, 1910.

In some of the valleys, at the time of survey, particularly of the North Branch of French Creek, Tionesta Creek, Clarion River, Mahoning Creek and Black Lick Creek, the snow, on the general level, measured from 7 to 30 inches in depth for the greater part of the time, which greatly retarded the progress of the field work. Drifts were sometimes encountered having depths of from 5 to 8 feet. Notwithstanding the great amount of snow and cold weather, however, the progress made seemed to warrant that the work be continued without interruption, especially as it was hoped, from time to time, that the weather would moderate. Even though the winter continued severe, it has been considered that, in the end, at least as good progress was made as if the parties, which totaled about 50 men, organized with considerable difficulty, had been

disbanded and work resumed at a later time, when many of the old men, who had become familiar with the work, would have been unavailable.

While these surveys were in progress, the general exploration of the drainage basins of the two rivers, which was being carried on by the Engineer in Charge, enabled the work to be planned in advance and proper instructions given to those in charge of parties.

The topographic surveys of the valleys were made with transit and stadia, supplemented occasionally by Locke levels. In a number of cases, by means of many side shots and short spur lines, the topography, including the stream and developments, was obtained for the full width of the valley, to above the flow line of the proposed reservoir, from a single survey line carefully run along or near the stream. Frequently, however, in addition to the line along the bottom of the valley, a line was run along one or both of the hillsides. In all cases, the topography was fully developed, in order to show all essential details of drainage, conformation and developments.

In addition to the general survey, in each case, special work was done and studies made at the site of the proposed dam, in order to obtain a reasonably careful estimate of the quantities and cost of the structure.

Levels for use in the stadia work were carried along the valleys, by the Wye level, from tide-water bench marks, which were either of U. S. Geological Survey or railroad origin. Ordinary bench marks were made at convenient intervals. When railroad benches were used, care was always taken to see that they were of a reliable nature.

Maps. The topographic maps of reservoir sites of the Flood Commission have been made on a scale of 1 inch to 400 feet, with contour intervals of 10 feet, and show all essential topographic details, such as streams and wooded areas, and all developments.

The work accomplished may be classified as given below. The letters indicating the groups are similarly used in Table No. 53, showing the cost of surveys and mapping in detail.

(A) Complete topography and control by Flood Commission, 25 projects. Scale, 1″ = 400′.
(B) Reconnoissance topography by Flood Commission, control by other sources, 5 projects. Scales, 3-1″ = 800′; 2-1″ = 1,000′.
(C) Topography and control by Flood Commission and U. S. Geological Survey, 3 projects. Scales, 1-1″ = 400′; 2-1″ = 500′.
(D) Developed from U. S. Geological Survey sheet and topography at site of dam by Flood Commission, 9 projects. Scale, 1″ = 100′.
(E) Reconnoissance, slight amount of survey data obtained, 4 projects.
(F) Reconnoissance only, 24 streams.

The topographic sheets of the U. S. Geological Survey were used in a number of cases, but surveys were always made at the sites of the proposed dams and the valley examined along the entire project, and beyond, notes being taken of important natural features and developments.

SPIRIT LEVELING BY FLOOD COMMISSION.

Relation to Other Lines of Levels. The levels of the Flood Commission at Pittsburgh are based on a precise line run by the U. S. Geological Survey from Erie, Pa., to Grafton, W. Va. To the former place the Survey ran a line through New York from Sandy Hook. At Grafton connection was made with the Coast and Geodetic Survey line, which runs from Sandy Hook, via Harrisburg and Cumberland, and con-

tinues westward from Grafton. At Pittsburgh, the Geological Survey connected with the precise line of the Pennsylvania R. R.

With the exception of those of the Baltimore & Ohio R. R. and the Pittsburgh & Lake Erie R. R., there are probably no other accurate levels in Pittsburgh, which have been run from Sandy Hook datum. It is understood that the Baltimore & Ohio R. R. levels are from this datum, but come from Washington, D. C. A difference of about 0.6 of a foot has been found between the levels of the Flood Commission and those of the Baltimore & Ohio R. R.

The levels are based on the Pennsylvania R. R. Bench No. 100, (Penn Avenue near Eleventh Street), which has an elevation of 743.932 feet above mean tide, Sandy Hook. This bench was originally placed by the Pennsylvania R. R. and their elevation was 744.082, determined from a line of precise levels brought from mean tide, Sandy Hook, in 1890. By the 1903 readjustment of the Coast and Geodetic Survey levels, in the eastern part of the United States, the U. S. Geological Survey made a corresponding readjustment, and the Pennsylvania R. R. bench was then given an elevation of 743.941. Through recent correspondence with the U. S. Geological Survey, it has been found that, by the last adjustment of this bench, the elevation is 743.932, and the levels of the Flood Commission have therefore been corrected to conform to this elevation.

The Flood Commission system of levels is the first of its kind carried out in the City of Pittsburgh. The work has been precisely done, and the errors or differences found with the levels of other systems have been noted in each particular case.

Description of Lines. The route of the lines forming the system of levels is as follows:

1. From Pennsylvania Railroad bench mark (No. 100) to U. S. Geological Survey bench mark, at Nadine Station, on the B. & A. V. Div. of the Pennsylvania Railroad, on the left bank of the Allegheny River. Distance, 8 miles.
2. From Pennsylvania Railroad bench mark to Glenwood highway bridge. Distance, 5.5 miles.
3. From Pennsylvania Railroad bench mark, across Monongahela River, via P., C., C. & St. L. Ry. bridge, to south abutment of Smithfield Street bridge. Distance, 1.4 miles.
4. From south abutment of Smithfield Street bridge to "Lockhart" monument of U. S. Engineer harbor line. Situated on left bank of Ohio River, at McKees Rocks. Distance, 3.7 miles.
5. From south abutment of Smithfield Street bridge to Carson Street near Thirty-sixth Street. Distance, 2.8 miles.
6. From Pennsylvania Railroad bench mark (No. 100), across the Allegheny River, via. P., Ft. W. & C. Ry. bridge, to station of railway on Federal Street, Northside. Distance 0.9 of a mile.
7. From P., Ft. W. & C. Ry. station to north end of Thirtieth Street bridge, on right bank of Allegheny River. Distance, 1.4 miles.
8. From P., Ft. W. & C. Ry. station to signal block of this railroad near Jacks Run, on right bank of Ohio River. Distance, 3.2 miles.
9. From Pennsylvania Railroad bench mark (No. 100) to "Point," thence by First Avenue to Grant Street, thence to point of beginning. Distance, 2.2 miles.

BENCH MARKS.

BRONZE TABLETS.

No.	Location.	Elevation.
1	Union Station: Right side of second step on stairway leading to the slope from Liberty Avenue	741.236
2	Keenan Bldg., cor. Liberty Avenue and Seventh Street: On sill (under window) just to right of Liberty Avenue entrance	734.903
3	Jos. Horne & Co. Bldg., cor. Fifth Street and Penn Avenue: Plate in wall facing Fifth Street, about 5 feet from Penn Avenue	730.923
4	Exposition: On pedestal left side of right entrance at west end Machinery Hall (in court at main entrance)	724.877
5	Riter Conley Co. Office Bldg., No. 55 Water Street: Left side of top step of Water Street entrance	734.185
6	Thaw Bldg., cor. First Avenue and Smithfield Street: Door sill left side of pillar, Smithfield Street entrance to corner store. This B. M. is not a tablet	746.925
7	Frick Bldg., Fifth Avenue and Grant Street: On pedestal of second column to left of Grant Street entrance	785.926
8	H. J. Heinz Co. Plate set in wall facing entrance to stables, on first building below Administration Building	728.419
9	Federal Street Station, P., Ft. W. & C. Ry: Left side of lower step, Federal Street entrance	733.429
10	Damascus Bronze Co., South Avenue and Sturgeon Street: Plate in wall on foundry building, facing South Avenue, about 4 feet from Sturgeon Street	722.641
11	Chas. Steiffel Co. Tannery, cor. Preble Avenue and Juniata Street: Plate set in wall facing Juniata Street	729.160
12	Armstrong Cork Co., Twenty-third Street: On stone balustrade, right side of Twenty-third Street entrance to office	731.207
13	Ward-Mackey Co. Bldg., Thirty-first Street and Liberty Avenue: Plate in wall facing Liberty Avenue, about 20 feet to left of eastern entrance	745.790
14	Jones & Laughlin Office Bldg., Keystone Works, No. 3140 Second Avenue: Plate set in stone balustrade left side of entrance	732.867
15	Pittsburgh Mercantile Co., cor. Twenty-sixth and Carson Streets, South Side: Plate set in stone sill of second window to right of Carson Street entrance	752.741
16	P. & L. E. Passenger Station, Smithfield Street, South Side: Plate in wall, river side of building, about 3 feet from northeast corner	736.775
17	P., C., C. & St. L. Ry. wall (Saw Mill Run): Plate set in top of wall about 100 feet below intersection of Steuben and Carson Streets	733.996

OTHER BENCH MARKS.

Allegheny River.

Left Bank, above Eleventh Street.

No.	Location.	Elevation.
18	B. M. No. 100, east side Penna. Co. Office Bldg., Penn Avenue and Tenth Street: Shelf on building	743.932
19	Right side of lower step, entrance Consolidated Storage Co., Thirteenth Street, near Pike: Square cut in stone	734.69
20	Right side of lower step, middle entrance to Polish Church, Twenty-first Street: Square cut in stone	735.68
21	Northeast corner, lower step, entrance Trinity Church, Twenty-fifth and Smallman Streets: Square cut in stone	737.11
22	Southwest corner lower step, entrance to store, southeast corner Smallman and Thirtieth Streets: Square cut in stone	734.81
23	Right side door sill, entrance to store, southwest corner Smallman and Thirty-first Streets: Square cut in stone	735.54
24	Left side, second step, northwest corner Smallman and Thirty-second Streets: Square cut in stone	737.10

Bronze Tablet used for Bench Marks

Allegheny River. Left Bank, Above Eleventh Street. (Continued.)

No.	Location.	Elevation.
25	Right side of door sill, southwest corner Smallman and Thirty-fourth Streets: Square cut in stone	732.06
26	Left side, lower step, main entrance, Valley House, thirty-sixth and Smallman Streets: Square cut in stone	738.12
27	Left side, lower step, southeast corner Foster and Thirty-eighth Streets: Square cut in stone	746.45
28	Left side, third step, No. 40 Forty-eighth Street, near Hatfield: Square cut in stone	749.75
29	Left side door sill, southwest corner Hatfield and Fiftieth Streets: Square cut in stone	753.05
30	Left side, lower step, entrance American Bridge Co. Bldg., Fifty-first Street: Square cut in stone	750.37
31	Northwest corner, upper step, entrance Pittsburgh Spring & Steel Co. office, McCandless Avenue: Square cut in stone	740.50
32	Left side, lower step, entrance Mt. Albion School, Butler Street: Square cut in stone	777.06
33	Right side door sill, 6130 Butler Street: Square cut in stone	782.88
34	On gas pipe, center of Butler Monument, U. S. Harbor Line, center Sharpsburg bridge, left bank	742.62
35	Brilliant Pump Station, lower corner of door step, machine shop: Square cut in stone	745.94
36	Pennsylvania Water Co.'s pump house, Nadine Station: Copper bolt in door sill	748.80
37	North side of lower step, entrance to Pittsburgh Post Office	749.87

Monongahela River.

Left Bank.

No.	Location.	Elevation.
38	Smithfield Street bridge, north side of south abutment, 17 feet east of the west end: Square shelf	726.54
39	Left side of door sill, entrance Dilworth, Porter & Co. office, northeast corner Bingham and Fourth Streets: Square cut in stone	729.51
40	Left side, lower step, entrance to A. Garrison Foundry Co. office, northeast corner Bingham and Ninth Streets: Square cut in stone	743.80
41	Right side of door sill, entrance to Ninth U. P. Church, southwest corner Bingham and Fourteenth Streets: Square cut in stone	756.31
42	Left side of lower step, Union Baptist Church, southeast corner Ninteenth Street and Wright Alley: Square cut in stone	754.78
43	Right side of door sill, entrance to Lotus Club, 2310 Sidney Street: Square cut in stone	755.36
44	On top stone step post, right side of entrance to Holy Cross Church, Carson Street, between Thirty-first and Thirty-second Streets	754.93
45	Right side of door sill, entrance to a dwelling, 3495 Carson Street: Square cut in stone	742.67
46	P. & L. E. R. R., southeast corner of pedestal of Williamsburg Water Tank (south pedestal next to tracks)	730.60

Allegheny River.

Right Bank.

No.	Location.	Elevation.
47	Northwest anchor bolt of newel post of iron fence on wall, right side of approach to Thirtieth Street bridge (River Avenue approach)	728.06
48	Top east end, east concrete door step, National Lead & Oil Co.'s Bldg., River Avenue	722.11
49	Top belt course, southwest corner, Bern Apts., River Avenue	729.26
50	Northeast corner belt course, southwest corner Main and Pine Streets	730.05

Allegheny River. Right Bank. (Continued.)

No.	Location.	Elevation.
51	Shelf on rock face retaining wall, north side W. P. R. R., 140 feet east of Pine Street, marked "B. M. No. 2"	739.21
52	Northwest corner belt course, southeast corner Walnut and Main Streets	728.29
53	North end, north door sill, 209 Madison Avenue	727.99
54	Northwest corner belt course, southeast corner Madison Avenue and Saw Mill Alley	725.83
55	Southwest corner belt course, northeast corner River and Madison Avenues	722.56
56	Northwest corner bridge seat, west abutment P., Ft. W. & C. Ry. bridge, River Avenue	736.60
57	Southwest corner belt course, northeast corner Anderson and River Avenues	727.70
58	Top lead plug, southwest corner west pedestal, north end Seventh Street bridge, B. & O. tracks	720.44
59	Northeast corner abutment wing wall, southeast corner Federal Street and River Avenue	733.14
60	Northwest corner, northeast pedestal, Anderson Street overhead P., Ft. W. & C. Ry. bridge	737.10
61	Northwest corner belt course, southeast corner Lacock and Goodrich Streets	728.20

Ohio River.

Right Bank.

No.	Location.	Elevation.
62	Left side of stone door sill, southwest corner Grant Avenue and South Avenue	725.35
63	Right side of concrete door step, northwest corner South Avenue and School Street	721.34
64	Right side of door sill, southwest corner Rebecca Street and Grant Avenue: Square cut in stone	726.63
65	Second step, southwest corner Rebecca Street and Allegheny Avenue: Square cut in stone	724.69
66	Right side of second step, entrance Barrett Mfg. Co.'s office, southeast corner Rebecca Street and Sproat Alley: Square cut in stone	725.80
67	Left side door sill, entrance Pittsburgh Clay Pott Co.'s office, 1247 Rebecca Street	728.88
68	Right side of door sill, entrance La Belle Steel Co.'s office, east side of Ridge Avenue, near Rebecca Street: Square cut in stone	726.96
69	Left side of first step, east side of No 59, Chartiers Street, near Rebecca Street: Square cut in stone	723.82
70	Stone door sill, right side, northeast corner Page and Beaver, Beaver Avenue entrance	728.72
71	On stone pedestal, northeast corner Beaver Avenue and Fayette Street: Square cut in stone	729.95
72	Stone door sill, northwest corner Beaver Avenue and Greenwood Street, Post Office Building: Square cut in stone	735.16
73	Left side stone door sill, southeast corner Preble Avenue and Bayard Street: Square cut in stone	730.98
74	Right side of door sill, southwest corner Preble and Island Avenues: Square cut in stone	733.00
75	Left side of lower step, entrance Pittsburgh Stove & Range Co. bldg., Preble Avenue between Island Avenue and Ontario Street: Square cut in stone	726.96
76	Stone pedestal at street crossing railroad east side of Preble Avenue, between Island Avenue and Ontario Street	729.94
77	Stone pedestal, southeast corner Preble Avenue and Ontario Street; Square cut in stone	728.76
78	Stone pedestal, southwest corner Preble Avenue and Kerr Street; square cut in stone	728.12
79	Stone pedestal, southwest corner Preble Avenue and Wilkins Street: Square cut in stone	726.80
80	Concrete pedestal, foot-bridge, crossing P., Ft. W. & C. Ry., Cass Avenue, opposite Pressed Steel Car Co.'s works: Square cut in stone	725.89
81	Coping stone, west edge of retaining wall, P., Ft. W. & C. Ry., Cass Avenue: Square cut in stone	731.98

Ohio River. Right Bank. (Continued.)

No.	Location.	Elevation.
82	Concrete pedestal, signal block, about 1,300 feet below above bench: Square cut in stone	728.99

Monongahela River.

Right Bank.

No.	Location.	Elevation.
83	Belt course, B. & O. R. R. retaining wall, 27 feet east of the one mile post: Square cut in stone	729.14
85	Copper tablet set in walk, 60 feet west of 4252 Second Avenue, marked Filbert Paving & Supply Co., Pittsburgh, Pa	769.11
86	West side, lower step, entrance to Hazelwood Annex of Hazelwood Public School: Square cut in stone	775.53
87	West side, step of L. Martine Bakery, 5406 Second Avenue: On extreme end—no cut marks on this	774.34
88	North end of west side, bridge seat, Glenwood highway bridge (between 2 large pipes): Square cut in stone	776.72

Left Bank.

No.	Location.	Elevation.
89	Stone pier of Wabash Railroad bridge, opposite telephone pole on Carson Street: Square cut in stone	732.90

Ohio River.

Left Bank.

No.	Location.	Elevation.
90	Lower door step, western side entrance to Lawrence Paint Works, on Carson Street: Square cut in stone	758.12
91	Small pier at end retaining wall of Corks Run viaduct, just south of Carson Street, on road to Sheraden: Square cut in stone	769.18
92	Highway bridge over Corks Run on Carson Street, northeast corner of south abutment and third course of stone from top: Square cut in stone	724.09
93	On small pier at east end stone wall, 128 Carson Street: Square cut in stone	729.91
94	Ohio River Connecting Bridge, recess cut in pier facing tracks, 19th course of stone from top, and 17 feet from south end of pier	727.67
95	Rough flag-stone, east end, at bottom of porch step, 408 Carson Street: Square cut in stone	724.34
96	U. S. G. S. B. M., copper tablet, north abutment, east side bridge seat, P. & L. E. R. R. bridge over Chartiers Creek	717.673
97	U. S. Harbor Line Monument, "Lockhart," about 5 feet east of Lockhart's pump house on left bank, back channel Ohio River, marked on copper tablet "Lockrt"	722.19

CHECKS.

Levels showing Results of Connections with Government Bench Marks.

No. 36	U. S. G. S. B. M. at Nadine Station.	
	Flood Commission, first running	748.789
	Flood Commission, second running	748.804
	Flood Commission, adjusted elevation	748.797
	U. S. Geological Survey	748.838
	Difference	.041
No. 37-A	U. S. Engineer bronze tablet, Oliver Building. (From P. R. R. B.M.)	743.459
	Flood Commission, adjusted elevation	743.448
	Difference	.011

CHECKS. (Continued.)

No. 38 Smithfield Street bridge, north side of south abutment, 17 feet east of west end: Square cut in masonry.

Flood Commission, first running	726.547
Flood Commission, second running	726.544
Flood Commission, third running	726.537
Flood Commission, adjusted elevation	726.542
U. S. Geological Survey elevation	726.730
Difference	.188

No. 84 Copper bolt in east end of retaining wall, south side of tracks at east end of train shed.

U. S. C. & G. Survey elevation	747.117
Flood Commission, adjusted elevation	746.981
Difference	.136

Levels showing Results of Connections with Railroad Bench Marks.

No. 38 Smithfield Street bridge, north side of south abutment, 17 feet east of west end: Square cut in masonry.

Flood Commission, first running	726.547
Flood Commission, second running	726.544
Flood Commission, third running	726.537
Flood Commission, adjusted elevation	726.542
P. & L. E. R. R. (main line elevation)	726.835
Difference	.293
P. & L. E. R. R. (P., McK. & Y. Div. elevation)	726.880
Flood Commission, adjusted elevation	726.542
Difference	.338

No. 94 Ohio Connecting Bridge, recess cut in pier facing tracks.

P. & L. E. R. R. elevation	727.949
Flood Commission, adjusted elevation	727.670
Difference	.279

No. 46 Williamsburg water tank, southeast corner of south pedestal next to tracks.

P. & L. E. R. R. elevation	730.877
Flood Commission, adjusted elevation	730.596
Difference	.281

No. 62-A Copper plug, southeast corner, north abutment, over B. & O. R. R. at old Union bridge.

B. & O. R. R. elevation	725.905
Flood Commission, adjusted elevation	725.308
Difference	.597

No. 84 Copper bolt in east end of retaining wall, south side of tracks at east end of train shed.

B. & O. R. R. elevation	747.600
Flood Commission, adjusted elevation	746.981
Difference	.619

CHECKS. (Continued.)

No. 84-A Copper bolt in southeast corner of bridge over Maurice Street, Pittsburgh, 1,000 feet west of mile post Baltimore 326.

B. & O. R. R. elevation	746.540
Flood Commission, adjusted elevation	745.930
Difference	.610

No. 84-B Copper bolt in bridge seat, west abutment of railroad bridge over Second Avenue.

B. & O. R. R. elevation	744.080
Flood Commission, adjusted elevation	743.468
Difference	.612

No. 4-A P., Ft. W. & C. Ry., south end bottom step, main entrance, Federal Street station.

P., Ft. W. & C. Ry. elevation	734.109
Flood Commission, adjusted elevation	733.915
Difference	.194

Results of Flood Commission Levels at Terminal Points.

No. 36 Nadine Station—Pennsylvania Water Company pump house.

Flood Commission, first running	748.789
Flood Commission, second running	748.804
Difference	.015

No. 88 Glenwood bridge, north abutment.

Flood Commission, first running	776.714
Flood Commission, second running	776.731
Difference	.017

No. 47 Thirtieth Street bridge, North Side.

Flood Commission, first running	728.072
Flood Commission, second running	728.050
Difference	.022

No. 82 On foundation on signal block, P., Ft. W. & C. Ry., near Jacks Run.

Flood Commission, first running	728.983
Flood Commission, second running	729.003
Difference	.020

No. 97 U. S. Harbor Line Monument "Lockhart," below Chartiers Creek.

Flood Commission, first running	722.178
Flood Commission, second running	722.197
Difference	.019

No. 45 Carson Street, near Thirty-sixth Street.

Flood Commission, first running	742.673
Flood Commission, second running	742.670
Difference	.003

COST OF SURVEYS, MAPPING AND INVESTIGATIONS.

CITY SURVEYS.

The cost of the city survey may be considered low, especially when taking into account certain drawbacks, such as new organization and the field troubles in conducting work under the conditions peculiar to this city. It has been subdivided and totaled as follows:

SURVEYS.

Land surveys, 4,960 acres	$ 2,395.00
Cost per acre	.48
Soundings, 9,000	550.00
Cost per 100 soundings	.61
Spirit leveling, 56 miles	230.00
Cost per mile	4.11

MAPPING.

Original maps, 13 sheets, scale 1″ = 160′	$ 2,205.00
Cost per square foot	25.06
Tracing and lettering the above sheets	760.00
Cost per square foot	8.67
Total area plotted, including rivers, 7,420 acres.	

FLOOD DAMAGE INVESTIGATIONS.

Collecting data	$ 784.00

SUMMARY.

Surveys	$ 3,175.00
Mapping, tracing, etc	2,965.00
Flood damage	784.00
Total	$ 6,924.00

SURVEYS OF RESERVOIR PROJECTS.

Regarding the reservoir site surveys, it may be said that, considering the information obtained, the cost is reasonable, and perhaps below the average of many other surveys of a similar nature. It must be realized that, with this work also, certain difficulties frequently were encountered, men new to the work, rough topography, wood and brush covered areas, and snow and fog. It is very likely that if an accurate table were made of comparative survey costs, under the various types of topographic conditions encountered, the valley type, especially where rugged and brushy, would average higher than the usual cross-country work. The long strip, composed considerably of continuous hillsides, with the dividing stream often interfering with easy communication, is the feature in such work that tends to increase the cost.

The total cost of surveys in the drainage basins, including the examination necessary for the selection of the sites, was $26,370. The average cost per acre of the 25 projects fully surveyed by the Commission was 32 cents. The average cost for those of rugged topography, 17 in number, was 41 cents per acre, while the average for those of gradually sloping topography, and in general having no particularly troublesome features, was 28 cents per acre. The range of cost for the rugged class was from 20 to 63 cents, and for the flatter and more open country, 16 to 53 cents.

The accessibility of the projects, the living accommodations and the road facilities had a great deal to do with the wide range occurring in each of the classes. The size

Project	TING MAPS			RECAPITULATION OF COSTS, SURVEYS AND MAPPING			
		Cost		Topography	Leveling	Mapping	Total
		sq. ft.	Total including materials				
Mahoning Creek No. 1	Fe	4.70	$ 94.50	$ 760.50	$ 104.00	$ 94.50	$ 959.00
" " No. 2	Ap	3.10	205.50	613.50	43.50	205.50	862.50
East Sandy Creek No. 1	Ma	3.80	52.00	121.00	15.50	52.00	188.50
" " " No. 2	Ma	6.30	52.00	151.50	7.50	52.00	211.00
Black Lick Creek	Ja	1.00	230.00	1822.50	73.50	230.00	2126.00
Little Sandy Creek	Ma	4.00	149.50	496.50	29.50	149.50	675.50
Crooked Creek	Ap	9.80	230.00	837.50	46.00	230.00	1113.50
Clarion River No. 1	Fel	6.40	172.50	1291.50	91.00	172.50	1555.00
" " No. 3	No / No	7.80	287.50	2457.00	77.00	287.50	2821.50
" " No. 4	Dec	8.80	202.50	869.00	37.00	202.50	1108.50
Tionesta Creek	No	0.00	322.50	2098.50	100.50	322.50	2521.50
Kinzua Creek	Jun	1.50	130.00	623.00	32.50	130.00	785.50
Sugar Creek	Ma	6.70	52.00	194.00	60.00	52.00	306.00
Cussewago Creek	Ma	5.50	212.50	1021.00	60.00	212.50	1293.50
North Br. French Creek	Fel	2.50	190.50	1016.50	72.50	190.50	1279.50
Laurel Hill Creek	Jur / Jur	3.90	94.50	560.50	52.00	94.50	707.00
Casselman River No. 1	Ma	9.20	46.50	92.50	9.50	46.50	148.50
" " No. 2	Ma	7.70	46.50	60.00	9.50	46.50	116.00
" " No. 3	Ma	5.00	46.50	92.50	9.50	46.50	148.50
" " No. 4	Ma	4.60	46.50	92.50	9.50	46.50	148.50
" " No. 5	Ma	2.80	46.50	124.50	9.50	46.50	180.50
Cheat River No. 1	Jar	3.70	163.00	1091.50	80.00	163.00	1334.50
" " No. 2	Dec	2.30	305.50	3117.00	199.50	305.50	3622.00
West Fork River	Jar	3.70	320.50	1991.50	242.00	320.50	2554.00
Elk Creek	Ap	2.10	172.50	707.50	72.50	172.50	952.50
Total, group (A)		----	3872.00	22303.50	1543.50	3872.00	27719.00
Average, group (A)		5.80	--------	--------	--------	--------	---------
French Creek	Au	3.30	185.50	172.00	--------	185.50	357.50
Allegheny River No. 1	Au	4.90	199.50	180.50	--------	199.50	380.00
" " No. 2	Sep	1.60	214.50	180.50	--------	214.50	395.00
" " No. 3	Sep	3.20	179.00	90.00	--------	179.00	269.00
Youghiogheny River No. 1	Jul	5.10	67.50	68.50	36.50	67.50	172.50
Total, group (B)		---	846.00	691.50	36.50	846.00	1574.00
Average, group (B)		3.30	--------	--------	--------	--------	---------
Loyalhanna Creek	Ma	5.60	100.50	664.00	56.50	100.50	821.00
Shavers Fork River No. 1	Au	3.90	63.00	130.50	--------	63.00	193.50
" " " No. 2	Au	8.30	78.00	130.50	--------	78.00	208.50
Total, group (C)		---	241.50	925.00	56.50	241.50	1223.00
Average, group (C)		1.70	--------	--------	--------	--------	---------
Youghiogheny River No. 2	Jul	---	26.00	23.00	--------	26.00	49.00
" " No. 3	Jul	---	26.00	23.00	30.00	26.00	79.00
" " No. 4	Jul	---	26.00	23.00	70.50	26.00	119.50
" " No. 5	Jul	---	26.00	115.00	71.00	26.00	212.00
Sandy Creek (W. Va.)	Aug	---	26.00	53.50	--------	26.00	79.50
Teters Creek	Aug	---	26.00	32.00	--------	26.00	58.00
Buckhannon River	Aug	---	26.00	80.00	--------	26.00	106.00
Middle Fork River No. 1	July	---	26.00	42.50	--------	26.00	68.50
" " " No. 2	July	---	26.00	85.50	--------	26.00	111.50
Total, group (D)		---	234.00	477.50	171.50	234.00	883.00
Average, group (D)		---	--------	--------	--------	--------	---------
Shade Creek	July		--------	41.00	27.50	--------	68.50
Hickory Creek	Jun	---	--------	57.50	16.00	--------	73.50
N. Br. of Red Bank Creek	No	---	--------	--------	21.00	--------	21.00
Total, group (E)		---	--------	98.50	64.50	--------	163.50
Average, group (E)			--------	--------	--------	--------	---------
Grand Total			$5193.50	$24496.00	$1872.50	$5193.50	$31562.00
Grand Average			--------	--------	--------	--------	---------

a. Average depth nd control by Flood Commission.
b. " " phy by Flood Commission, control from other sources.
c. " " l by Flood Commission and U. S. Geological Survey.
d. " " eological Survey sheets and topography at site of dam
e. " "
f. " " mount of survey data obtained.
g. " "

COST OF SURVEYS, MAPPING AND INVESTIGATIONS.

CITY SURVEYS.

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Soundings, 9,000	550.00
Cost per 100 soundings	.61
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Cost per mile	4.11

MAPPING.

Original maps, 13 sheets, scale 1″ = 160′	$ 2,205.00
Cost per square foot	25.06
Tracing and lettering the above sheets	760.00
Cost per square foot	8.67
Total area plotted, including rivers, 7,420 acres.	

FLOOD DAMAGE INVESTIGATIONS.

Collecting data	$ 784.00

SUMMARY.

Surveys	$ 3,175.00
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Flood damage	784.00
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SURVEYS OF RESERVOIR PROJECTS.

Regarding the reservoir site surveys, it may be said that, considering the information obtained, the cost is reasonable, and perhaps below the average of many other surveys of a similar nature. It must be realized that, with this work also, certain difficulties frequently were encountered, men new to the work, rough topography, wood and brush covered areas, and snow and fog. It is very likely that if an accurate table were made of comparative survey costs, under the various types of topographic conditions encountered, the valley type, especially where rugged and brushy, would average higher than the usual cross-country work. The long strip, composed considerably of continuous hillsides, with the dividing stream often interfering with easy communication, is the feature in such work that tends to increase the cost.

The total cost of surveys in the drainage basins, including the examination necessary for the selection of the sites, was $26,370. The average cost per acre of the 25 projects fully surveyed by the Commission was 32 cents. The average cost for those of rugged topography, 17 in number, was 41 cents per acre, while the average for those of gradually sloping topography, and in general having no particularly troublesome features, was 28 cents per acre. The range of cost for the rugged class was from 20 to 63 cents, and for the flatter and more open country, 16 to 53 cents.

The accessibility of the projects, the living accommodations and the road facilities had a great deal to do with the wide range occurring in each of the classes. The size

TABLE No. 53.

COST OF RESERVOIR SURVEYS AND MAPS

	TOPOGRAPHY										LEVELING						DRAFTING MAPS			RECAPITULATION OF COSTS, SURVEYS AND MAPPING			
Project	Inclusive dates in field	Character of country: Wooded %	Character of country: Rugged %	Road facilities	Total working days	Days actually worked	Area covered per day actually worked (Acres)	Total area surveyed (Acres)	Cost: Per acre	Cost: Total*	Inclusive dates in field	Total working days	Days actually worked	Total miles run	Cost: Per mile	Cost: Total*	Scale of working maps	Cost: Per sq. ft.	Cost: Total including materials	Topography*	Leveling*	Mapping	Total
Mahoning Creek No. 1	Feb. 25, '10—Apr. 1, '10	62	30	a fair	31	27	66	1769	$0.43	$ 760.50	Feb. 20, '10—Mar. 7, '10	13	6	12.0	$8.66	$ 104.00	1" 400'	$ 24.70	$ 94.50	$ 760.50	$ 104.00	$ 94.50	$ 959.00
" " No. 2	Apr. 2, '10—Apr. 30, '10	50	40	"	25	21	105	2209	0.28	613.50	Mar. 29, '10—Apr. 1, '10	4	4	15.4	2.82	43.50	"	43.10	205.50	613.50	43.50	205.50	862.50
East Sandy Creek No. 1	May 26, '10—May 30, '10	66	80	good	4	2	97	193	0.63	121.00	May 24, '10—May 25, '10	2	2	3.5	4.43	15.50	"	123.80	52.00	121.00	15.50	52.00	188.50
" " " No. 2	May 31, '10—June 5, '10	79	80	"	5	3	85	254	0.60	151.50	May 31, '10	1	1	1.5	5.00	7.50	"	96.30	52.00	151.50	7.50	52.00	211.00
Black Lick Creek	Jan. 27, '10—Mar. 24, '10	45	40	b good	49	30	88	3432	0.53	1822.50	Jan. 20, '10—Jan. 27, '10	7	3	9.0	8.17	73.50	"	31.00	230.00	1822.50	73.50	230.00	2126.00
Little Sandy Creek	May 2, '10—May 26, '10	24	75	poor	22	18	71	1280	0.39	496.50	Apr. 13, '10—Apr. 14, '10	2	2	7.0	4.21	29.50	"	54.00	149.50	496.50	29.50	149.50	675.50
Crooked Creek	Apr. 9, '10 May 17, '10	21	15	good	33	29	123	3671	0.23	837.50	Apr. 7, '10—Apr. 12, '10	5	5	13.0	3.53	46.00	"	29.80	230.00	837.50	46.00	230.00	1113.50
Clarion River No. 1	Feb. 9, '10—Apr. 8, '10	85	80	c fair	51	41	74	3028	0.43	1291.50	Feb. 8, '10—Feb. 19, '10	11	11	28.0	3.25	91.00	"	26.40	172.50	1291.50	91.00	172.50	1555.00
" " No. 3	Nov. 9, '09—Dec. 11, '09 Nov. 11, '09—Feb. 3, '10	79	75	d fair	102	92	52	4785	0.51	2457.00	Nov. 6, '09—Nov. 16, '09	9	8	28.2	2.73	77.00	"	27.80	287.50	2457.00	77.00	287.50	2821.50
" " No. 4	Dec. 13, '09—Jan. 20, '10	73	70	e good	34	23	142	3254	0.27	869.00	Dec. 16, '09—Dec. 21, '09	5	5	12.0	3.08	37.00	"	28.80	202.50	869.00	37.00	202.50	1108.50
Tionesta Creek	Nov. 20, '09—Feb. 24, '10	61	65	f good	83	65	57	3734	0.56	2098.50	Nov. 18, '09—Nov. 24, '09	6	5	15.0	6.70	100.50	"	40.00	322.50	2098.50	100.50	322.50	2521.50
Kinzua Creek	June 6, '10—June 29, '10	56	45	"	21	18	106	1912	0.33	623.00	June 6, 7, 8, 18, 1910	4	4	6.0	5.42	32.50	"	31.50	130.00	623.00	32.50	130.00	785.50
Sugar Creek	May 16, '10—May 25, '10	16	15	"	9	6	151	904	0.21	194.00	Feb. 18, '10—Feb. 26, '10	8	7	12.3	4.88	60.00	"	26.70	52.00	194.00	60.00	52.00	306.00
Cussewago Creek	Mar. 28, '10—May 14, '10	12	10	"	42	36	176	6339	0.16	1021.00	Feb. 28, '10—Mar. 5, '10	6	6	6.0	10.00	60.00	"	15.50	212.50	1021.00	60.00	212.50	1293.50
North Br. French Creek	Feb. 2, '10—Mar. 26, '10	17	30	g fair	45	40	98	3912	0.26	1016.50	Feb. 8, '10—Feb. 17, '10	9	9	19.0	3.82	72.50	"	22.50	190.50	1016.50	72.50	190.50	1279.50
Laurel Hill Creek	June 2, '10 June 17, '10 June 20, '10—July 7, '10	78	60	"	24	18	72	1292	0.43	560.50	May 30, '10—June 6, '10	7	5	12.0	4.34	52.00	"	33.90	94.50	560.50	52.00	94.50	707.00
Casselman River No. 1	May 15, '10—May 18, '10	68	80	poor	3	3	61	184	0.50	92.50	Mar. 12, '10	1	1	4.3	2.21	9.50	"	119.20	46.50	92.50	9.50	46.50	148.50
" " No. 2	May 19, '10—May 20, '10	100	85	"	2	2	124	248	0.24	60.00	Mar. 14, '10	1	1	1.8	5.28	9.50	"	87.70	46.50	60.00	9.50	46.50	116.00
" " No. 3	May 21, '10—May 21, '10	96	85	"	3	2	144	288	0.32	92.50	Mar. 15, '10	1	1	2.0	4.75	9.50	"	75.00	46.50	92.50	9.50	46.50	148.50
" " No. 4	May 25, '10—May 27, '10	85	70	"	3	1	256	256	0.36	92.50	Mar. 16, '10	1	1	1.5	6.33	9.50	"	84.60	46.50	92.50	9.50	46.50	148.50
" " No. 5	May 28, '10—June 1, '10	85	70	"	4	2	172	344	0.36	124.50	Mar. 17, '10	1	1	2.4	3.96	9.50	"	62.80	46.50	124.50	9.50	46.50	180.50
Cheat River No. 1	Jan. 26, '10—Mar. 11, '10	57	80	"	39	32	173	5518	0.20	1091.50	Jan. 24, '10—Feb. 2, '10	9	8	24.0	3.33	80.00	"	13.70	163.00	1091.50	80.00	163.00	1334.50
" " No. 2	Dec. 29, '09—May 12, '10	20	70	fair	116	102	62	6354	0.49	3117.00	Dec. 29, '09—Feb. 3, '10	32	22	31.6	6.31	199.50	"	22.30	305.50	3117.00	199.50	305.50	3622.00
West Fork River	Jan. 26, '10 Apr. 15, '10	25	20	good	69	60	181	10815	0.18	1991.50	Jan. 26, '10—Mar. 1, '10	30	26	53.6	4.51	242.00	"	13.70	320.50	1991.50	242.00	320.50	2554.00
Elk Creek	Apr. 16, '10—May 12, '10	10	40	"	23	19	191	3620	0.20	707.50	Mar. 2, '10—Mar. 11, '10	9	9	22.0	3.30	72.50	"	22.10	172.50	707.50	72.50	172.50	952.50
Total, group (A)					842	701	---	69495	---	22303.50		184	153	343.1	---	1543.50	---	---	3872.00	22303.50	1543.50	3872.00	27719.00
Average, group (A)		55	56		---	---	---	---	0.32	---		---	---	---	4.50	---	---	25.80	---	---	---	---	---
French Creek	Aug. 22, '10—Aug. 29, '10	23	20	good	7	6	479	2871	0.06	172.00	Erie R. R. levels	---	---	---	---	---	1"–1000'	213.30	185.50	172.00	---	185.50	357.50
Allegheny River No. 1	Aug. 31, '10—Sept. 8, '10	55	50	"	8	6	428	2564	0.07	180.50	P. R. R. & U. S. Govt. levels	---	---	---	---	---	1"–800'	164.90	199.50	180.50	---	199.50	380.00
" " No. 2	Sept. 9, '10—Sept. 18, '10	27	50	"	8	7	493	3451	0.05	180.50	P. R. R. & U. S. Govt. levels	---	---	---	---	---	"	131.60	214.50	180.50	---	214.50	395.00
" " No. 3	Sept. 19, '10—Sept. 22, '10	36	50	"	4	3	880	2641	0.03	90.00	P. R. R. & U. S. Govt. levels	---	---	---	---	---	"	143.20	179.00	90.00	---	179.00	269.00
Youghiogheny River No. 1	July 8, '10—July 11, '10	20	35	"	3	3	266	731	0.09	68.50	July 5, 12, 13, 1910	3	3	9.0	4.06	36.50	1"–1000'	305.10	67.50	68.50	36.50	67.50	172.50
Total, group (B)					30	25	---	12258	---	691.50		3	3	9.0	---	36.50	---	---	846.00	691.50	36.50	846.00	1574.00
Average, group (B)		32	41		---	---	---	---	0.06	---		---	---	---	4.06	---	---	163.30	---	---	---	---	---
Loyalhanna Creek	Mar. 25, '10—Apr. 19, '10	40	40	fair	22	19	157	2989	0.22	664.00	Mar. 22, '10—Mar. 31, '10	9	8	26.0	2.17	56.50	1"–400'	15.60	100.50	664.00	56.50	100.50	821.00
Shavers Fork River No. 1	Aug. 11, '10—Aug. 15, '10	30	65	"	5	4	150	599	0.22	130.50	No Wye levels run	---	---	---	---	---	1"–500'	173.90	63.00	130.50	---	63.00	193.50
" " " No. 2	Aug. 16, '10—Aug. 20, '10	55	90	poor	5	4	327	1306	0.10	130.50	No Wye levels run	---	---	---	---	---	"	98.30	78.00	130.50	---	78.00	208.50
Total, group (C)					32	27	---	4894	---	925.00		9	8	26.0	---	56.50	---	---	241.50	925.00	56.50	241.50	1223.00
Average, group (C)		42	65		---	---	---	---	0.19	---		---	---	---	2.17	---	---	31.70	---	---	---	---	---
Youghiogheny River No. 2	July 14, '10	11	40		1	1	---	---	---	23.00	U. S. G. S. sheets	---	---	---	---	---	1"–100'	---	26.00	23.00	---	26.00	49.00
" " No. 3	July 15, '10	95	90		1	1	---	---	---	23.00	Feb. 14, '10—Feb. 16, '10	8	2	8.0	10.00	30.00	"	---	26.00	23.00	30.00	26.00	79.00
" " No. 4	July 16, '10	50	80		1	1	---	---	---	23.00	Feb. 17, '10—Feb. 24, '10	7	4	7.0	10.07	70.50	"	---	26.00	23.00	70.50	26.00	119.50
" " No. 5	July 21, '10—July 25, '10	90	80		5	2	---	---	---	115.00	Feb. 25, '10—Mar. 4, '10	7	4	8.0	8.88	71.00	"	---	26.00	115.00	71.00	26.00	212.00
Sandy Creek (W. Va.)	Aug. 5, '10—Aug. 6, '10	52	40		2	1	---	---	---	53.50	U. S. G. S. sheets	---	---	---	---	---	"	---	26.00	53.50	---	26.00	79.50
Teters Creek	Aug. 3, '10—Aug. 4, '10	30	55		2	1	---	---	---	32.00	U. S. G. S. sheets	---	---	---	---	---	"	---	26.00	32.00	---	26.00	58.00
Buckhannon River	Aug. 8, '10—Aug. 10, '10	93	20		3	2	---	---	---	80.00	U. S. G. S. sheets	---	---	---	---	---	"	---	26.00	80.00	---	26.00	106.00
Middle Fork River No. 1	July 26, '10—July 27, '10	97	90		2	2	---	---	---	42.50	U. S. G. S. sheets	---	---	---	---	---	"	---	26.00	42.50	---	26.00	68.50
" " " No. 2	July 28, '10—Aug. 1, '10	98	90		4	3	---	---	---	85.50	U. S. G. S. sheets	---	---	---	---	---	"	---	26.00	85.50	---	26.00	111.50
Total, group (D)					21	14	---	---	---	477.50		17	10	18.0	---	171.50	---	---	234.00	477.50	171.50	234.00	883.00
Average, group (D)		68	65		---	---	---	---	---	---		---	---	---	9.53	---	---	---	---	---	---	---	---
Shade Creek	July 18, '10—July 20, '10	85	80		3	2	---	---	---	41.00	July 18, '10—July 20, '10	3	2	8.0	3.44	27.50	---	---	---	41.00	27.50	---	68.50
Hickory Creek	June 30, '10—July 1, '10	15	35		2	2	---	---	---	57.50	June 29, '10—June 30, '10	2	2	2.0	8.00	16.00	---	---	---	57.50	16.00	---	73.50
N. Br. of Red Bank Creek	No survey	90	65		---	---	---	---	---	---	June 8, '10—June 9, '10	2	2	9.0	2.33	21.00	---	---	---	---	21.00	---	21.00
Total, group (E)					5	4	---	---	---	98.50		7	6	19.0	---	64.50	---	---	---	98.50	64.50	---	163.50
Average, group (E)		63	60							---		---	---	---	3.39	---				---	---	---	---
Grand Total		---	---		930	771				$24496.00		220	180	415.1	---	$1872.50			$5193.50	$24496.00	$1872.50	$5193.50	$31562.00
Grand Average		55	57		---	---				---		---	---	---	$4.51	---			---	---	---	---	---

a. Average depth of snow 15 inches for period of 10 working days.
b. " " " 11 " " " 25 " "
c. " " " 24 " " " 20 " "
d. " " " 20 " " " 42 " "
e. " " " 20 " " entire period of survey.
f. " " " 24 " " period of 26 working days.
g. " " " 20 " " " 26 " "

*Includes salaries, subsistence and traveling expenses.

(A) Complete topography and control by Flood Commission.
(B) Reconnoissance topography by Flood Commission, control from other sources.
(C) Topography and control by Flood Commission and U. S. Geological Survey.
(D) Developed from U. S. Geological Survey sheets and topography at site of dam by Flood Commission.
(E) Reconnoissance, slight amount of survey data obtained.

of the project also had considerable influence; for instance, East Sandy Nos. 1 and 2, among the smallest of the rugged class, cost 63 cents per acre, the reason for this high cost being largely that the parties traveled daily to the work by train and the service was poor.

Cheat No. 1 shows a low cost, 20 cents per acre, especially when considering that the greater part of the country is unusually rugged. The party had become experienced and worked well together, so that this survey was executed expeditiously. On another project in this region, and on three or four in the Allegheny Basin, the acre cost runs higher than it should, considering the conditions that obtained. The projects range in length from about one mile to thirty miles, and the difference in level covers, in many places, about 200 feet.

The details and totals of the cost of surveying and mapping the reservoir sites are shown in the accompanying table, No. 53, where the projects are grouped according to the method of survey.

SUMMARY OF ALL ENGINEERING WORK, FIELD AND OFFICE.

To March 1, 1911.

Reservoir surveys and original maps*	$31,562
City surveys and original tracings*	6,140
Equipment, field and office	1,101
Hydrography, stream studies	3,195
Forest examinations	1,500
Studies, maps, etc., for report*	12,340
Total	$55,838

* Includes materials.

APPENDIX No. 5.

METHODS OF FLOOD RELIEF IN FOREIGN COUNTRIES.

Introduction—Flood Protection—Flood Prevention by Storage Reservoirs—Russia—Germany—Austria — France — Spain — Canada —Mississippi River.

With few exceptions, all communities situated on low ground bordering rivers have suffered to a greater or less extent from inundation and have had to face the problem of flood relief. European cities and towns, as compared with the phenomenal development in America, have had a gradual growth that has extended over centuries instead of decades and has given opportunity for a better and more complete solution of this problem; and it is quite natural that, in Europe, the construction of flood relief works should be further advanced than in this country. It is to be expected, moreover, that countries that have given such thorough and successful attention to the development of their natural inland waterways for navigation, should have made notable progress in river regulation.

As a rule, the methods of flood relief employed in foreign countries have, until comparatively recent years, been some form of local protection, as walls or dikes, filling in of low ground, straightening, deepening and widening of river channels, etc. The works on the Danube, at Vienna and Budapest, are notable examples of these methods of flood relief. In certain cases, where the conditions were favorable, diversion channels have been built to accommodate the discharge in excess of the carrying capacity of the natural channel. This method has been recommended by the Flood Commission of Paris in its recent report, the studies having shown that by the construction of a diversion channel about 20 miles long, taking part of the flood flow of the Marne to the north around the city, and emptying into the Seine below the city, at Epinay, a reduction of 5.7 feet in a flood similar to that of 1910 could be obtained at a cost of $34,000,000. Local treatment of the flood problem by one or another of the above methods has been so widely followed, and, in each case, is so entirely governed by the local conditions, that it would seem useless and of little interest to give space in this discussion to the numerous examples of flood protection.

In comparatively recent years, however, another method of flood relief has been successfully employed in European countries, that of flood prevention by storage reservoirs. This is of such peculiar interest in connection with the report of this Commission, which so largely deals with a solution of the Pittsburgh Flood Problem by means of reservoir control, that the success of such works in other countries has been treated at length in the following pages, in order to show that, despite the doubts of the feasibility of this method which have been expressed, reservoirs for impounding and controlling damaging flood waters have been built and are being successfully operated.

RUSSIA

The greatest system of artificial reservoirs in Europe is located at the headwaters of the Volga and Msta rivers in Russia. The Volga, the greatest river in Europe, rises about 200 miles southeast of St. Petersburg, and flows eastwardly for about half its length of 2,325 miles, and then southwardly into the Caspian Sea. The Msta rises near the same point, but flows in a general northerly direction into the Baltic Sea.

The two river systems have for a long time been connected by artificial water-

ways, but navigation was not possible, except during high water, until advantage was taken of the natural reservoir sites afforded by the numerous lakes near the sources of the two rivers, which were converted into enormous storage reservoirs by the construction of low dams across their outlets. The combined capacity of the system is about 35,000,000,000 cubic feet, the largest reservoir having a capacity of 14,000,000,000 cubic feet. This system of reservoirs has been notably successful in preventing floods and in improving the navigation on the two rivers, the benefit to the latter being felt on the Volga for a distance of over 450 miles, and both rivers being navigable for three months longer than formerly.

GERMANY

The construction of storage reservoirs as a means of flood control has probably been more extensively carried on in Germany than in any other country. A number of these reservoirs are intended solely for purposes of flood control, while others are, in addition, used for navigation, power development and water supply.

WUPPER RIVER.

The Wupper River drains about 240 square miles and empties into the Rhine on the east bank at Rheindorf. Before the construction of the dams, the river, on account of its steep slope and deforested, mountainous drainage basin, had a very irregular discharge. In long periods of drought it dropped as low as 0.05 second-foot per square mile, while in high water it often rose to 90 second-feet per square mile. The cities of Barmen and Elberfeld are on its banks and were often inundated, while the numerous water power plants along the stream suffered very greatly from the low water. After long deliberation, the Wupper Dam Association was formed, for the control and improvement of the river, and this Association has built the following two dams for the regulation of the flow.

Bever Valley Dam. The Bever enters the Wupper in its upper course, near Hückeswagen. The dam on this stream, built in 1898, controls a drainage area of about 9 square miles and creates a reservoir of 116,500,000 cubic feet capacity, of which about 18,000,000 cubic feet are kept empty during the flood season. The dam is 52.5 feet high and was built at a cost of $343,200, or $2,950 per million cubic feet of storage.

Lingese Valley Dam. This stream enters the Wupper near its headwaters, not far from Marienheide. In 1900, a dam was built in its valley, storing the run-off from about 4 square miles. The capacity of the reservoir is 92,000,000 cubic feet, of which 3,500,000 cubic feet are reserved for the storage of flood water. The dam is 61 feet high and cost $256,800, or $2,800 per million cubic feet of storage.

These dams, which have given excellent results, are supplemented in their control of floods by the storage in six other reservoirs, built for domestic and industrial supply, varying in capacity from 10,600,000 cubic feet to 211,800,000 cubic feet, and in cost, from $1,930 to $8,670 per million cubic feet of storage. Another dam is now under construction, in the Kerspetal, a tributary in the upper basin of the Wupper. The reservoir has a catchment area of 10.6 square miles and a capacity of 564,800,000 cubic feet. The total area of the Wupper Basin controlled by these 9 reservoirs is 37 square miles, or 15 per cent. The total capacity of the 9 projects is 1,242,560,000 cubic feet.

RUHR RIVER.

The Ruhr is the next tributary of the Rhine north of the Wupper, entering the Rhine from the east a short distance below Düsseldorf. It flows through the great

iron and steel center of Germany, around Essen, Steele and Mülheim, and the main river and its tributaries are extensively used as a source of domestic and industrial water supply.

There are 12 reservoirs on the tributaries of the Ruhr, built at various times between 1894 and 1910. These reservoirs control an aggregate drainage area of 71 square miles and have a combined storage capacity of 1,447,300,000 cubic feet, the individual capacities varying from 17,650,000 cubic feet to 353,000,000 cubic feet. The dams are of masonry, arched upstream, and vary in height from 64 to 114 feet. The total cost of the work was $3,480,720, the cost per million cubic feet in the various projects varying from $1,765 to $4,400. The flood water stored in these reservoirs is used directly for domestic and industrial supply, and, in some cases, also for power development. The reservoirs were constructed for the additional purpose of improving the low-water flow of the Ruhr for domestic and industrial supply and for power purposes.

RUR RIVER.

The Rur River enters the Rhine from the south, near Düsseldorf. On one of its principal tributaries, the Urft River, is located the highest and one of the most notable dams in Europe, built in 1901-1904, for the purpose of flood storage and water power development. The water is conducted through a tunnel 9,200 feet long to the power station on the Rur River north of the reservoir, where it drops 360 feet and develops an average of 4,800 horsepower and a maximum of 12,000 horsepower.

The drainage area above the dam is 145 square miles, of which 53 per cent is wooded. The maximum discharge of the Urft River is about 20 second-feet, the minimum about 0.18 second-foot, and the average about 1.46 second-feet per square mile of drainage area.

The dam contains 185,650 cubic yards of masonry, and is curved in plan, with a radius of 656 feet and a crest length of 741 feet. The maximum height is 190 feet, the thickness at the base 166 feet and at the top 18 feet. On the upstream face of the dam an earthen embankment is built to within 82 feet of the crest, sloping back to the reservoir bed with a 2 to 1 slope paved with rock. The reservoir has a capacity of 1,606,000,000 cubic feet, a surface area of 534 acres, a maximum depth of 172 feet and an average depth of 69 feet. The cost of $1,000,000, or $620 per million cubic feet of storage, was borne by an association made up of the City of Aachen and surrounding communities. No assessment has been made on the interests benefited below.

During the great flood of February, 1909, the Urft reservoir effectively protected the entire Rur valley. At this time the discharge of the Rur at Heimbach was 8,825 second-feet, greater than ever before recorded; while the Urft, which empties into the Rur a few miles above Heimbach, reached an unusual height, with a discharge of about 3,530 second-feet. Had the flood flow of these two streams been combined, a great rise and much damage would have resulted; but the Urft reservoir impounded 706,000,000 cubic feet without taxing the capacity, and the calamity was avoided.

NECKAR RIVER

The Neckar River rises in the southern part of Wurttemberg, in southwestern Germany, and flows in a general northerly direction, emptying into the Rhine at Mannheim. It has a total length of 228 miles and a drainage area of 8,665 square miles.

The Department of the Interior of Wurttemberg has charge of all river work, including the maintenance of navigation and the prevention of floods. One-third the expense of such work is borne by the State, one-third by the municipalities and one-third

by the property owners benefited. In very large and expensive undertakings the Government pays one-half the cost.

A number of small reservoirs have been built for storing flood water, the largest of which has a capacity of about 22,000,000 cubic feet. Some of these reservoirs are emptied after each flood, while others are kept partly full, a certain amount of capacity being reserved for storage of flood water.

WEISERITZ RIVER

The Weiseritz River rises in the mountains south of Dresden and flows northwardly for about fifty miles, emptying into the Elbe just below the city. It drains about 148 square miles, 37 per cent of which is forest covered, and has a maximum discharge of 10,200 second-feet, or 69 second-feet per square mile, and a minimum of 1.4 second-feet, or about 0.01 second-foot per square mile.

In a single flood in 1897, the losses along this stream amounted to over $2,000,000. Immediately after this flood, $1,250,000 was spent for flood protection work, and since then further measures of flood relief have been taken, including the construction of seven reservoirs. The two largest of these reservoirs are now completed, one at Malter, on the Red Weiseritz, and the other at Klingenberg, on the Wild Weiseritz. The Malter reservoir has a collection area of 40 square miles, and a capacity of 308,875,000 cubic feet. The dam is 115 feet high, 630 feet long, 18 feet wide on top and 98 feet wide at the base. The entire cost, including land damages and relocation of railroad, highways, etc., amounted to $883,000, or about $2,860 per million cubic feet of storage. The Klingenberg reservoir controls a drainage area of 35 square miles, and has a capacity of 536,150,000 cubic feet. The dam is 128 feet high, 1,017 feet long, 18 feet wide on top and 113 feet wide at the base. The total cost was $858,000, or $1,600 per million cubic feet. The water supply for a suburb of Dresden is taken from this reservoir.

These reservoirs reduce the maximum flow from 10,200 second-feet to 6,000 second-feet, which can be carried by the channel without overflow. The impounded water is released during low water and raises the minimum discharge from 1.4 second-feet to 70 second-feet.

WESER RIVER

The greatest artificial reservoir in Europe, except those in Russia at the headwaters of the Volga and Msta rivers, is now under construction near Hemfurt on the Eder River, a tributary of the Weser, and will be completed in 1913. The reservoir is intended for the storage of the winter and spring flood water, for the feeding of the Rhine-Weser Canal and for the raising of the low-water stage of the Weser in summer and autumn. This increase in low-water stage of the Weser will be about 1.2 feet at Hann Münden, 50 miles below the dam, and 0.5 foot at Minden, 124 miles further downstream. From 3,000 to 5,000 horsepower will be developed at the dam.

The drainage area tributary to the reservoir is 552 square miles, the discharge from which at the dam site varies between 0.05 second-foot and 58 second-feet per square mile. The reservoir has a capacity of 7,144,720,000 cubic feet, a surface area of 2,964 acres, a length of 15.5 miles and a maximum depth of 126 feet. The dam contains 392,222 cubic yards of masonry, quarried in the neighborhood, and is curved upstream with a radius of 1,640 feet and a crest length of 1,345 feet. The maximum height above the bed of the valley is 136 feet, the width on top is 20.5 feet and on the bottom 110 feet. The project will cost $4,500,000, or $630 per million cubic feet of storage. Two-thirds of this money is appropriated by the Prussian Landtag and one-third by the City of Bremen, which is located at the mouth of the Weser.

The construction of another large reservoir on the Weser Basin is planned but not yet begun, on the Diemal, near Helminghausen.

ODER RIVER

The Oder River rises in the mountains in the north of Bohemia and flows in a northwesterly direction through Prussia, emptying into the Baltic Sea a short distance below the City of Stettin. The river passes only about 50 miles to the east of Berlin, and as it is connected by canals with that city and thence with the Elbe River, and is navigable for nearly its entire length, it is an important stream commercially. The head of navigation is at Cosel, in the southern part of the Province of Silesia, and from here downstream to Breslau, the capital of the province, a distance of about 90 miles, the river is slackwatered.

Reservoirs for Flood Control and Navigation Purposes.

Below Breslau the low-water stage gives about 3.9 feet depth, 0.7 foot less than the required depth for navigation. This lack of depth continues, gradually diminishing, to a point about 120 miles below, where the necessary depth of 4.6 feet becomes available. The extension of the system of locks and dams through this stretch was at one time considered, but it has finally been decided to obtain the additional depth by the construction of two large reservoirs on tributaries of the Oder above Breslau, which will perform the double purpose of controlling floods and of increasing the low-water stage by the release of the water thus impounded. The required increase of 0.7 foot in the stage can be obtained by an additional flow of about 700 second-feet. The plans for these reservoirs are now completed, but work is not as yet begun. They will be built under the direction and at the expense of the Prussian Government.

The larger of the two reservoirs is on the Glatzer Neisse, one of the principal upper tributaries of the Oder, entering on the left bank about 40 miles above Breslau. The drainage area above the dam is 906 square miles, mostly mountainous and hilly country, about 30 per cent of which is wooded. The annual rainfall varies between 25 and 32 inches, and the stream at the dam site has a maximum discharge of 42,360 second-feet, a minimum of 141 second-feet and an average of 3,177 second-feet.

The dam, as proposed, is of earth, 37 feet high, 16,400 feet long and 26 feet wide on top, with 3 to 1 slopes on both sides, the upstream slope being faced with a layer of gravel about a foot thick. The reservoir has a maximum capacity of 3,600,600,000 cubic feet, 635,400,000 cubic feet of which are reserved for flood control. About 1,500 horsepower will be developed at the dam, while numerous small mills below will benefit by the improved flow and are to be assessed accordingly. The work will take from 5 to 6 years and will cost $3,840,000, or about $1,070 per million cubic feet of storage.

The other reservoir is on the Malapane, a tributary entering the Oder from the east, about 50 miles above Breslau. The drainage area above the dam is 403 square miles, 50 per cent of which is in forest. The mean annual rainfall is about 28 inches, and the stream at the dam site has a maximum discharge of 10,590 second-feet, a minimum of 88 second-feet and an average of 282 second-feet.

The cross-section of the dam is similar to that of the Glatzer Neisse dam, with a maximum height of 33 feet and a crest length of 15,420 feet. The maximum capacity of the reservoir is 3,124,050,000 cubic feet, 370,650,000 cubic feet of which are reserved for flood control. It is planned to develop about 750 horsepower at the dam, and to obtain some revenue from assessments upon the numerous water power interests benefited by the increased low-water flow. The project will cost about $2,880,000, or $900 per

million cubic feet of storage, and it is estimated that it will take five years to build.

The flood control effected by these reservoirs is intended as a means of relief additional to extensive channel improvements and dikes which are planned and already partly carried out, as a result of the serious flood damages which have been experienced along the valley of the Oder, particularly at the City of Breslau.

The Oder Improvement Bureau, of the Prussian Government, examined in all about 150 locations for reservoirs to increase the low-water flow of the Oder for navigation purposes. Ten sites, in addition to the two described above, were selected, and preliminary plans and estimates were made; but it has not as yet been definitely decided to build any of these reservoirs except the two large projects mentioned, for which final plans and estimates are completed. The capacities and costs of the ten projects upon which preliminary estimates were made are as follows:

1. *Lazisk Reservoir.* On a tributary of the Olsa River, which enters the Oder on the right about 115 miles above Breslau. Capacity, 618,300,000 cubic feet. Cost, $840,000, or $1,360 per million cubic feet of storage.

2. *Schwesterwitz Reservoir.* On the Straduna River, which enters the Oder on the left about 80 miles above Breslau. Capacity, 169,560,000 cubic feet. Cost, $833,000, or $4,900 per million cubic feet of storage.

3. *Lobkowitz Reservoir.* On the Hotzenplotz, which enters the Oder on the left about 70 miles above Breslau. Capacity, 324,000,000 cubic feet. Cost, $1,309,000, or $4,000 per million cubic feet of storage.

4. *Krappitz Reservoir.* Also on the Hotzenplotz River. Capacity, 270,000,000 cubic feet. Cost, $785,000, or $2,900 per million cubic feet of storage.

5. *Dembiohammer Reservoir.* On a tributary of the Malapane River. Capacity, 704,700,000 cubic feet. Cost, $1,561,000, or $2,220 per million cubic feet of storage.

6. *Schulenburg Reservoir.* On a tributary of the Malapane River. Capacity, 475,200,000 cubic feet. Cost, $968,000, or $2,030 per million cubic feet of storage.

7. *Waltdorf Reservoir.* On a tributary of the Glatzer Neisse. Capacity, 108,270,000 cubic feet. Cost, $607,000, or $5,600 per million cubic feet of storage.

8. *Hünern Reservoir.* On the Hünernbach, a small tributary emptying into the Oder on the left bank, about 22 miles above Breslau. Capacity, 247,050,000 cubic feet. Cost, $642,000, or $2,600 per million cubic feet of storage.

9. *Altstadt Reservoir.* On the Weide River, which empties into the Oder from the right about 6 miles below Breslau. Capacity, 247,050,000 cubic feet. Cost, $1,428,000, or about $5,800 per million cubic feet of storage.

10. *Raaben Reservoir.* On a tributary of the Weistritz River, which empties into the Oder on the left bank about 6 miles below Breslau. Capacity, 391,500,000 cubic feet. Cost, $1,119,000, or $2,860 per million cubic feet of storage.

Reservoirs for Flood Control and Power Purposes.

Extensive investigations of the feasibility of constructing storage reservoirs for the prevention of the damaging floods in the valley of the Oder and its tributaries in Silesia were carried on under the direction of the Prussian Minister of Commerce and Trade in 1895-1898. Many possible locations for reservoirs were found, and a number that were very favorable. These reservoirs were to be primarily for flood prevention and secondarily for industrial uses.

The Act of July 3rd, 1900, granted about $9,300,000 for the construction of flood control reservoirs on certain dangerous tributaries on the left of the Oder. The surveys and investigations were then continued by the Province of Silesia and a number of

additional favorable sites studied. Up to the middle of 1911, 16 projects had been adopted, and of these, 7 reservoirs had been completed, 6 more were under construction and plans and estimates for 3 more were ready. The reservoirs, with the exception of the Marklissa and Mauer projects, which are also used to develop power, are constructed simply for flood prevention and are usually kept empty and ready to store flood water.

In all, 38 favorable locations were found, and for the 22 in addition to the 16 mentioned above, the cost of construction has been tentatively estimated, but they have not as yet been adopted. Twelve of these 22 projects would be used for power development, as well as for flood control.

The 13 reservoirs which have been completed or are now under construction are described below:

1. *Arnoldsdorf Reservoir.* This reservoir is located near Arnoldsdorf, on the Goldbach, a tributary of the Hotzenplotz, which enters the Oder on the left bank about 70 miles above Breslau. The dam is of earth and the reservoir will have a capacity of 79,380,000 cubic feet. The work was begun in 1906 and is not yet completed. The cost of the project will be $119,000, or about $1,500 per million cubic feet of storage.

2. *Woelfel Reservoir.* This reservoir was built in 1905-1908 on the Woelfelsbach, an upper tributary of the Glatzer Niesse. It has a capacity of 32,130,000 cubic feet and controls a drainage area of about 10 square miles. The dam is of masonry, arched upstream, with a radius of 820 feet, and is 98 feet high, 10 feet wide on top, 62 feet wide at the base and 361 feet long. The total cost of the work was $124,000, or $3,860 per million cubic feet of storage.

3. *Seitenberg Reservoir.* The Seitenberg reservoir is located near the village of that name on a tributary near the headwaters of the Glatzer Neisse, which enters the Oder on the left bank about 40 miles above Breslau. The dam is of earth and the reservoir has a capacity of 40,500,000 cubic feet. The work was carried out in 1905-1908, at a cost of $68,000, or $1,680 per million cubic feet of storage.

4. *Schönau Reservoir.* This reservoir is located on the Steinbach, a small tributary of the Katzbach, which enters the Oder on the left bank, 33 miles below Breslau. The work was begun in 1907 and is still under way. The dam is of earth and the reservoir will have a capacity of 56,430,000 cubic feet. The estimated cost of the project is $90,000, or $1,600 per million cubic feet of storage.

5. *Klein-Waltersdorf Reservoir.* This reservoir was begun in 1909, on a tributary near the headwaters of the Katzbach, and is not yet completed. It has an earthen dam and will have a capacity of 16,930,000 cubic feet. The project will cost $40,000, or $2,360 per million cubic feet of storage.

6. *Buchwald Reservoir.* This reservoir is located near Buchwald, not far from the headwaters of the Bober, the drainage area above the dam being only 23 square miles. The dam is of masonry, and is 48 feet high and 722 feet long. The reservoir has a capacity of 77,660,000 cubic feet and was built in 1903-1906 at a total cost of $262,000, or about $3,400 per million cubic feet of storage.

7. *Grüssau Reservoir.* The Grüssau Reservoir is located on an upper tributary of the Bober, about 6 miles above Landeshut. The dam is of earth and the reservoir has a capacity of 28,080,000 cubic feet. The project was built in 1903-1906 at a cost of $86,000, or $3,060 per million cubic feet of storage.

8. *Zillerthal Reservoir.* This reservoir was begun in 1909, on an upper tributary of the Bober, and is not yet completed. It has an earthen dam and will have a capacity of 105,840,000 cubic feet. The total cost will be $274,000, or about $2,600 per million cubic feet of storage.

9. *Herischdorf Reservoir.* This reservoir is located on the Heidewasser, a tributary of the Bober, near Herischdorf. It has a capacity of 141,200,000 cubic feet and controls a drainage area of about 36 square miles. The dam is of earth, with a maximum height of 27.5 feet and a crest length of 4,920 feet. It was built in 1903-1906 at a total cost of $219,000, or $1,550 per million cubic feet of storage.

10. *Warmbrunn Reservoir.* This reservoir was built in 1906-1908, on an upper tributary of the Bober. The dam is of earth, 23 feet high and 9,840 feet long, and the reservoir has a capacity of 211,950,000 cubic feet and a catchment area of 46 square miles. The total cost of the project was $381,000, or $1,800 per million cubic feet of storage.

11. *Mauer Reservoir.* The largest reservoir on the Bober, near Mauer, was begun in 1905 and is now nearly completed. It has a capacity of 1,765,000,000 cubic feet and controls a drainage area of 467 square miles. The dam is built of masonry, arched upstream, and when completed will be 196 feet high, or 6 feet higher than the Urft Dam. The total cost of the work will be about $1,785,000, or about $1,010 per million cubic feet of storage. About 60 per cent of the capacity will be reserved for flood control and the remainder used for power development.

12. *Friedeberg Reservoir.* This reservoir is located on a tributary of the Queiss, about 11 miles above the Marklissa Reservoir, and controls a drainage area of about 24 square miles. It was begun in 1908 and is not yet completed. The earthen dam is 37 feet high and 1,968 feet long, and the reservoir will have a capacity of 120,150,000 cubic feet. The estimated cost is $119,000, or $990 per million cubic feet of storage.

13. *Marklissa Reservoir.* The Marklissa Reservoir is located on the Queiss River a few miles above Marklissa. This stream rises in the mountains of southern Silesia and flows northwardly into the Bober River, which empties into the Oder at Crossen. The Queiss flows parallel to and about 20 miles to the east of the Görlitzer Neisse, and in topography, rainfall and run-off is very similar to that stream, the same heavy rainfalls having repeatedly caused destructive floods on both streams.

The drainage area above the dam is 118 square miles and the reservoir has a capacity of 529,500,000 cubic feet, and a surface area of 346 acres. The dam, which is of masonry, arched upstream, is 141 feet high, 27 feet wide on top, 124 feet wide at the base and 426 feet long. It was built in 1901-1904 by the Province of Silesia at a cost, including land, damages, etc., of $750,000, or $1,418 per million cubic feet of storage.

The design of this reservoir is based upon a careful study of the flood of 1897, the greatest ever experienced on the Queiss River. The channel of the Queiss at Marklissa will carry 3,880 second-feet without overflow, and during the flood of 1897, the discharge rose to 27,530 second-feet, or about 230 second-feet per square mile. The discharging apparatus at the dam is so arranged that 3,880 second-feet can be released during the filling of the reservoir. At the level where the capacity of 529,500,000 cubic feet is reached, which is 6.5 feet below the crest of the dam, there are two spillways, one on each side of the valley, with a total crest length of 223 feet. When the water reaches this level and begins to flow over the crests of these spillways, the gates are gradually closed as the water rises so as to keep the discharge at 3,880 second-feet. As a head of 3 feet on the spillways is necessary to give the allowable discharge of 3,880 second-feet, the additional capacity of 42,360,000 cubic feet, due to this added depth, can be regarded as a protection against floods, bringing the total capacity of the reservoir for flood protection up to 571,860,000 cubic feet.

The reservoir is arranged so that 176,500,000 cubic feet are kept filled, but, on

the approach of a flood, can be released in time to make the full capacity of the reservoir available for flood control. This water is used for the development of power, at a power station located a few hundred feet below the dam, where about 1,000 horsepower is developed during the four dryest months and 2,400 horsepower during the other eight months of the year. The release of this water during the low-water season increases the flow of the Queiss to about 140 second-feet, or about four times its former minimum, which is of great benefit to the numerous mills on the stream below the dam.

The following are the three reservoirs for which plans and estimates are prepared:

1. *Kaufung Reservoir.* On the Katzbach, near the headwaters. Capacity, 24,003,000 cubic feet. Cost, $63,000, or $2,630 per million cubic feet of storage.

2. *Grabel Reservoir.* On a tributary of the Katzbach. Capacity, 31,590,000 cubic feet. Cost, $71,000, or $2,250 per million cubic feet of storage.

3. *Alt-Weissbach Reservoir.* On a tributary of the Bober. Capacity, 18,522,000 cubic feet. Cost, $59,000, or $3,180 per million cubic feet of storage.

AUSTRIA

In Austria, the most important work of flood control by means of storage reservoirs is that on tributaries of the Oder and Elbe Rivers in Bohemia.

ODER RIVER

One of the most notable groups of reservoirs built for flood control in Europe is composed of six projects on the Görlitzer Neisse, near Reichenberg, in Bohemia. This stream rises in northern Bohemia and flows northwardly for 124 miles, emptying into the Oder River about 15 miles below Crossen in Prussia. Its valley receives a heavy precipitation in its upper portion, 13.5 inches in 24 hours having been recorded at some points, and has been repeatedly devastated by floods; so that after the great flood of 1888, an association was formed to plan and carry out the construction of protection and regulation works, consisting of widening and straightening the channel and raising and protecting the banks. The estimated cost of these improvements was so heavy, and their probable effectiveness in a great flood so doubtful, however, that practically nothing was done by the association, the actual work confining itself to the repairing of damages and the building of the bank protections most urgently needed by the individual property owners.

In July, 1897, this part of Europe was again visited by devastating floods, which so revived public interest in flood relief that a convention, in which all the neighboring cities and towns were represented, was held in Reichenberg in the fall of that year. At this meeting it was decided to investigate the feasibility of constructing reservoirs for flood control. In January, 1901, the preliminary studies were sufficiently complete to establish the general plans, which contemplated the construction of six reservoirs in the neighborhood of Reichenberg, controlling the run-off from about 29 square miles, and in critical flood time holding back about 3,530 second-feet of damaging flood discharge.

The result of the investigations gained the Association many new supporters and assured the sympathy of the population of the entire valley of the Neisse with the project. In fact, one of the most noteworthy features of this undertaking is the widespread interest it aroused in the surrounding country and the universal financial support it received. Although all the reservoirs are located in Bohemia, the benefits both in flood control and increase of low-water flow are felt by the Saxon and Prussian interests along its lower course, and these two countries, together with various cities, communities and private interests, coöperated with Bohemia in their construction. The total cost

of the work was $1,320,000 and the following contributions show the extent of the co-operation:

Bohemian Government	$660,000
Prussian Government	38,400
Prussian Province of Silesia	9,600
Prussian County of Ober-Lausitz	14,400
City of Görlitz (Prussia)	14,400
Saxon Government	24,000
Combination of Saxon and Prussian Water Interests	72,000

It is also of special interest that the users of water for power development from the Grünwald, Harzdorf and Friedrichswald reservoirs pay $12 per horsepower, and from the other three reservoirs, $28 per horsepower per year. The total contribution to the low-water flow of the Neisse from the six reservoirs is about 34 second-feet.

The main features of the six reservoirs are as follows:

Harzdorf Reservoir. This reservoir controls the run-off from 6 square miles, and has a maximum capacity of 22,239,000 cubic feet, 8,119,000 cubic feet of which are reserved for flood control. The dam is of masonry, arched upstream with a radius of 394 feet, and is 62 feet high, 15 feet wide on top, 53 feet wide at the base and 515 feet long, containing in all, 20,918 cubic yards of masonry. On the upstream side, as in the Urft Dam, an earthen embankment rises to about two-thirds the height of the dam, sloping back to the stream bed with a 3 to 1 paved slope. The work was carried out in 1902-1904 at a cost of $119,000 for the dam, and a total cost of $165,000, or $7,419 per million cubic feet of storage.

A short distance above slackwater of the reservoir, there is a weir with an automatic self-registering gage, which has an electric signal connecting with the house of the watchman at the dam, so that when the inflow exceeds a certain prescribed amount, he is warned and can operate the gates and regulating apparatus accordingly.

Friedrichswald Reservoir. This reservoir has a catchment area of about 1.6 square miles and a maximum capacity of 70,600,000 cubic feet, 35,300,000 cubic feet of which are reserved for storage of flood water. The dam, which is of masonry, arched upstream with a radius of 984 feet, is 92 feet high, 15 feet wide on top, 65 feet wide at the base and 1,115 long. It contains 54,911 cubic yards of masonry, and was built in 1902-1906 at a cost of $320,000 for the dam proper, and a total cost of $360,000, or $5,100 per million cubic feet of storage.

Voigtsbach Reservoir. The watershed above this dam includes an area of 2.7 square miles, and the dam creates a storage of 8,825,000 cubic feet. The dam is of masonry, arched upstream with a radius of 574 feet, and is 52 feet high, 15 feet wide on top, 35 feet wide at the base and 538 feet long. It contains 15,690 cubic yards of masonry and was built in 1904-1906. The cost for the dam and appurtenances was $83,600, and the total cost was $94,400, or $10,700 per million cubic feet of storage.

Mühlscheibe Reservoir. This reservoir has a catchment area of 2.6 square miles and a capacity of 8,825,000 cubic feet. The dam is of masonry, arched upstream with a radius of 656 feet, and is 72 feet high, 15 feet wide on top, 48 feet wide at the base and 508 feet long. It contains 20,918 cubic yards of masonry, and was built in 1904-1906, at a cost of $123,000, or $14,000 per million cubic feet of storage.

Gorsbach Reservoir. This reservoir, which is not yet completed, controls a drainage area of 4.6 square miles and has a capacity of 17,650,000 cubic feet, 8,825,000 cubic feet of which are reserved for flood control. The dam is 70.5 feet high, 15 feet

wide on top, 47 feet wide at the base and 848 feet long, being arched upstream with a radius of 738 feet. It contains 41,837 cubic yards of masonry and its total cost when completed will be $206,000, or $11,670 per million cubic feet of storage.

Grünwald Reservoir. The drainage area above the dam is 10.3 square miles, 8.1 square miles of which are tributary to two other small streams, their flood run-off being conducted to this reservoir, which has a capacity of 95,310,000 cubic feet. The dam is of masonry, arched upstream with a radius of 1,148 feet, and is 65.6 feet high, 15 feet wide on top, 49 feet wide at the base and 1,378 feet long. It contains 56,218 cubic yards of masonry, and was built in 1906-1908 at a cost of $540,000, or $5,770 per million cubic feet of storage.

ELBE RIVER

The work of constructing storage reservoirs for flood control has been carried out on the Elbe River and tributaries in Bohemia since 1903 by a Commission for River Regulation. The work of this Commission includes reforestation for the purpose of retarding the run-off and preventing erosion, about $145,000 having been expended for this purpose in 1906-1909. Sixty per cent of the cost of carrying out the work of the Commission is appropriated by the Austrian Government and forty per cent by the Bohemian Government. The following reservoirs are now being built:

Königreiche-Walde Reservoir. This reservoir is located above Königinhof, on the main river near its source in northern Bohemia, the drainage area above the dam being 200 square miles. It has a capacity of 320,887,000 cubic feet, of which 268,487,000 cubic feet are reserved for flood water. The dam is of masonry, arched upstream, and is 136 feet high, 23.6 feet wide on top, 124 feet wide at the base and 735 feet long. The total cost of the work will be $965,000, or about $3,000 per million cubic feet of storage.

Spindlemühle Reservoir. This reservoir is also located on the main river, further upstream than the Königreiche-Walde Reservoir, and has a catchment area of 22.4 square miles. The capacity of the reservoir is 119,500,000 cubic feet, of which 106,000,000 cubic feet are reserved for flood storage. The dam is of masonry, arched upstream, and is 136 feet high, 16.4 feet wide on top, 118 feet wide at the base and 492 feet long. The spillway and discharging apparatus can accommodate 7,060 second-feet, or 316 second-feet per square mile of drainage area. The work when completed will cost $652,880, or $5,464 per million cubic feet of storage.

Hlinsko Reservoir. This reservoir is located near the headwaters of the Chrudimka, a tributary of the Elbe, rising in eastern Bohemia and flowing northward into the Elbe at Pardubitz. The drainage area above the dam is 21.6 square miles and the reservoir has a capacity of 81,190,000 cubic feet, 60,010,000 cubic feet of which are reserved for flood control. The dam is of earth, 40 feet high, 16.4 feet wide on top and 656 feet long. It will cost, when completed, about $150,000, or $1,850 per million cubic feet of storage.

Parizov Reservoir. This reservoir is located on the Doubravka, the next important tributary of the Elbe west of the Chrudimka, entering the main river from the south, above Kolin. The reservoir has a catchment area of 80.7 square miles and a capacity of 60,010,000 cubic feet. The dam is of masonry, arched upstream, and is 101 feet high, 14.8 feet wide on top and 84.8 feet wide at the base. The total cost will be $299,686, or $5,000 per million cubic feet of storage.

In addition to the projects described above, the following reservoirs are proposed:

On the Aupa River. The Aupa rises in the extreme eastern part of Bohemia and

flows westwardly into the Elbe at Königgratz. Its tributaries are subject to frequent sudden floods during which extremely high rates of run-off are attained, and it is therefore an important contributor to high water in the Elbe. Three reservoirs are to be constructed on its tributaries.

1. Below the junction of the Great and Little Aupa. The drainage area above the dam is 29.7 square miles, from which the maximum recorded discharge is 10,943 second-feet or 370 second-feet per square mile. The reservoir will have a capacity of 123,-550,000 cubic feet. It will cost $1,220,000, or $9,880 per million cubic feet of storage.

2. On the Little Aupa. The reservoir will have a catchment area of 11.9 square miles and a capacity of 106,711,900 cubic feet, of which 88,250,000 cubic feet will be reserved for flood water. The dam will be of masonry, arched upstream, and will be 157 feet high above the foundation, 19.7 feet wide on top and 593 feet long. There will be a spillway 98 feet wide on top of the dam to accommodate the maximum flood discharge of 4,589 second-feet, or 385 second-feet per square mile of drainage area. It will cost $800,000, or $7,500 per million cubic feet of storage.

3. Near Slatina. The drainage area above the proposed dam is 158.6 square miles and the capacity of the reservoir will be 307,110,000 cubic feet. The dam will be of masonry, 115 feet high above the foundation, 23 feet wide on top and 712 feet long. The spillway over the dam will accommodate the maximum discharge of 11,650 second-feet. The estimated cost is $850,000, or $2,770 per million cubic feet of storage.

On the Doubrava. The reservoir will have a catchment area of 37.3 square miles and a capacity of 48,000,000 cubic feet. The dam will be of earth, 37 feet high, 20 feet wide on top and 703 feet long.

On the Kreibitzbache, near Kreibitz. The reservoir will have a catchment area of 24.7 square miles and a capacity of 31,770,000 cubic feet. The dam will be of earth, 77 feet high. The total cost will be $126,460, or $4,000 per million cubic feet of storage.

On the Sazawa, near Sechau. The drainage area above the proposed dam is 166 square miles, and the capacity will be about 400,000,000 cubic feet.

On the Boticbache, near Hostivau. The reservoir will have a capacity of 27,922,300 cubic feet and will cost $207,137, or $7,400 per million cubic feet of storage.

On the Iser. Two reservoirs are proposed on this stream, together controlling a drainage area of 8.8 square miles, and having a combined capacity of 225,920,000 cubic feet, 76,543,000 cubic feet of which will be reserved for flood control. The total cost will be $458,000, or about $2,027 per million cubic feet of storage. These reservoirs are to be built by private enterprise for water power development, but the work will be aided by a contribution from the Commission for River Regulation on account of the above mentioned capacity reserved by agreement for flood control.

Studies have also been completed for six other reservoirs for flood control on tributaries of the Elbe in Bohemia.

WIEN RIVER

The Wien River is a small stream rising to the westward of the City of Vienna and flowing in a general easterly direction into the Danube at Vienna. It drains an area of about 86 square miles and has a very irregular flow, being subject to frequent sudden freshets, which in past years have caused great damage in Vienna, as the river flows directly through the city.

In the early nineties, studies for a method of relief from these floods were taken up by the Department of Public Works of Vienna and plans were prepared for their control and for the improvement of the channel for some distance above its mouth. This work was carried out in the years 1895-1900 and consists of the walling-up of the

channel from the mouth to Weidlingau, a distance of about 10.6 miles, and of the construction of seven small reservoirs near the head of this walled-in stretch, at the villages of Weidlingau and Hadersdorf.

The system of reservoir control is designed upon the basis of a possible maximum run-off of 330 second-feet per square mile of drainage area. The reservoirs stretch along the side of the valley for about a mile and are separated from the river channel by a heavy concrete wall, and from each other by low concrete dams, forming a series of terraces with about 6.5 feet difference in elevation between each water surface. They have a combined capacity of 56,480,000 cubic feet and are designed to hold back the flood flow in excess of the carrying capacity of the channel below Weidlingau. This is accomplished by means of an ingenious regulating device at the upper end of the works, which allows any desired amount of the flood flow to be diverted into the reservoirs. This flood water is only temporarily stored, being released as soon as the discharge has fallen sufficiently. The reservoir furthest upstream serves as a settling basin for gravel, sand and silt, and prevents this material from passing down the channel or into the lower reservoirs. The beds of the lower basins are used for raising grass, two crops of which are cut annually, while in winter the basins are flooded and the ice is harvested.

The total cost of the reservoirs was $1,680,000. Several floods have occurred since their completion and they have served their purpose admirably.

FRANCE

The great floods of 1856 in France agitated the question of flood prevention by reservoir control. Elaborate studies were made on the Rhone, Garonne and Loire rivers, by order of Emperor Napoleon III, and the findings of the French engineers are included in the following:

RHONE RIVER

The Rhone rises in eastern Switzerland and flows westwardly through Lake Geneva into France, where it is joined at Lyons by its principal tributary, the Saone, and flows southwardly for 205 miles into the Mediterranean. It has a total length of about 450 miles and a drainage area of about 36,700 square miles.

At a cost of $6,800,000, 7,500,000,000 cubic feet of storage could be created above Lyons, where the drainage area is about 20,500 square miles. The reduction of the 1856 flood that would have been effected thereby was estimated as 3.3 feet at Lyons, which would have gradually diminished downstream. Additional storage of about 11,000,000,000 cubic feet could have been created upon the Durance for about the same amount, but as this tributary enters the Rhone only about 60 miles from the sea, where the flood discharge is very considerable, the storage would have had relatively small effect in reducing the flood height on the main river, and this only for a short distance. The studies demonstrated, therefore, that a reduction of flood height could be obtained by reservoir control, but that owing to the lack of suitable sites, sufficient storage could not be created to reduce floods below the stage where they would cause damage.

This investigation does much to prove the effectiveness of artificial storage. With only 7,500,000,000 cubic feet of storage a reduction of 3.3 feet in flood height could have been obtained at a point in the river where the total drainage area is 20,500 square miles. Had suitable sites been available for the creation of, say, 25,000,000,000 cubic feet of reservoir capacity, a not unreasonable amount, a reduction of over 10 feet could doubtless have been obtained.

The consideration of the effect of the natural storage on the flow of the Rhone at Lyons is interesting and suggestive. The drainage area above the city is about the same as at Pittsburgh, and both cities are located at the confluence of two large rivers. Both the Rhone and the Saone have extensive natural storage, and its effect is very noticeable in their discharge.

On the Rhone, 131 miles above Lyons, is Lake Geneva, with a surface area of 223 square miles, or about 8 per cent of the tributary drainage area of 2,663 square miles. One foot rise in the level of this lake represents a storage of 6,200,000,000 cubic feet. In the great flood of 1856 the Rhone discharged into Lake Geneva at the rate of 42,360 second-feet, or 21 second-feet per square mile. At this rate, for the entire drainage area, including the lake, the discharge below Geneva would have been 56,480 second-feet. It actually amounted to only 11,472 second-feet, or only 4.3 second-feet per square mile. The lake, therefore, acted as a natural reservoir and its storage reduced the flow of the Rhone by about 45,000 second-feet.

On the Saone there is a very large natural storage, amounting to fully 50,000,000,000 cubic feet, due to the overflow of the bottom lands in its valley for a stretch of 100 miles above Lyons. As a result, the run-off of the Saone in the great flood of 1856 was only 4 second-feet per square mile.

Without these two natural storage reservoirs, the flow of the Rhone at Lyons would undoubtedly have been more than twice as great. The actual discharge amounted to less than 250,000 second-feet, or to but very little more than the flow at the 22-foot stage at Pittsburgh. Had this natural storage been artificially created by means of a number of reservoirs, its effect would have been the same.

There is practically no natural storage on the Allegheny or Monongahela Basins. The surveys of this Commission, however, have shown that favorable sites exist for the creation of artificial storage to the amount of over 100,000,000,000 cubic feet, and the conditions on the Rhone at Lyons are an admirable illustration of the effect of such storage.

GARONNE RIVER

The investigations on this river showed that if artificial storage of about 33,000,000,000 cubic feet capacity could be created, the greatest floods could be kept within the river banks. The reservoir plan was rejected because of the difficulty of obtaining suitable sites, and because the cost of constructing reservoirs, $24,000,000, was considered excessive.

LOIRE RIVER

The French engineers recommended the project of controlling the Loire by storage reservoirs, but the work has never been carried out, as the estimated cost of about $13,000,000, though no greater than the flood damages at Pittsburgh in the last ten years, was considered too great. The effectiveness of this method of flood control is demonstrated by the findings of the board of engineers.

The Loire River is formed by the junction of the upper Loire and Allier rivers at the city of Nevers. The former drains about 7,000 and the latter about 4,500 square miles. The conditions affecting run-off are very similar on the two streams and their flood waves arrive at Nevers at practically the same time.

The investigations showed that about 8,250,000,000 cubic feet of storage could be created on the Upper Loire by the construction of 22 reservoirs, and about 10,000,000,-

000 cubic feet on the Allier by building 63 reservoirs These reservoirs would reduce the maximum flow of the Upper Loire from 153,600 second-feet to 111,700 second-feet, and of the Allier from 167,700 second-feet to 104,700 second-feet; a total reduction of about 105,000 second-feet from a total flow of 321,000 second-feet, or over 30 per cent. This would reduce floods below the danger line for a distance of about 180 miles below the junction of the rivers, while above this point, the effect would be much greater.

The Allegheny at Pittsburgh and the Loire at Nevers are very similar in size of drainage area and in maximum flow. The studies of the French engineers have shown that with a storage of 18,250,000,000 cubic feet on the Loire, the floods can absolutely be controlled and reduced below the danger line for a distance of 180 miles below the city of Nevers. The reservoirs proposed on the Allegheny Basin have a combined capacity of about 50,000,000,000 cubic feet, or nearly three times the capacity of the storage that was proposed on the Loire.

SEINE RIVER

The Flood Commission of Paris, appointed at the time of the disastrous floods of the Seine in February and March, 1910, issued its report during the summer of that year, and with regard to reservoirs as a means of flood control, stated that this method is not applicable to the basin of the Seine. It could only be applied on two tributaries, the Upper Seine and the Aube, where 7,000,000,000 cubic feet of storage would have an appreciable effect on the floods in the Seine at Paris, but the construction of the necessary reservoirs would involve prohibitive land damage, as a rich farming country would be flooded.

OTHER RIVERS.

There are three notable reservoirs for flood control in France. The Furens Dam was built by the French Government in 1862 to protect the town of St. Etienne from the floods of the Furens River. It is a curved masonry dam about 184 feet high and 326 feet long on the crest, and stores about 56,500,000 cubic feet. The cost was $318,000, or about $5,630 per million cubic feet of storage, 60 per cent of which was contributed by the town of St. Etienne in return for the use of the stored water for its domestic supply. The Ternay Dam, on the River Ternay, in southern France, was built in 1865 for the purpose of controlling the floods of the Ternay, and supplying water to the neighboring town of Annonay. The masonry dam is curved upstream and has a maximum height of 119 feet. The capacity of the reservoir is about 91,800,000 cubic feet, and the cost $204,372, or $2,226 per million cubic feet of storage. The third reservoir, on the Var River, near Riom, has a masonry dam 130 feet high.

SPAIN

The worst flood conditions in Spain are experienced in the eastern part, on the Segura River, the shortest of the important rivers of that country, which rises at an elevation of about 5,100 feet above sea-level and flows eastwardly for about 210 miles, entering the Mediterranean near Alicante. The drainage area is about 4,830 square miles, the maximum discharge about 52,000 second-feet and the minimum discharge 106 second-feet. The annual rainfall is comparatively light, the maximum recorded being 16 inches and the minimum 6 inches. The climate is hot and dry, and droughts are of frequent occurrence, while floods are generally the result of cloud-bursts or cyclones.

A special commission of engineers appointed by the Spanish Government, with headquarters at the city of Murcia, has charge of works for flood prevention and pro-

tection in the eastern provinces. The flood relief work includes reforestation, dykes at low points, overflow canals and storage reservoirs.

The flood control reservoirs are also used for irrigation purposes during the summer droughts that are so prevalent in this rich agricultural region. Four of these reservoirs are now completed and eight more are planned. The dams vary in height from 100 to 134 feet.

CANADA

The largest system of artificial reservoirs in the world is now being constructed on the Ottawa River in Canada. This river rises about 150 miles north of the city of Ottawa, Ontario, flows westwardly from its source for a considerable distance, thence southwardly for 100 miles, and then turns sharply to the east at Mattawa, where the junction with the proposed Georgian Bay Ship Canal would be made, and continues its easterly course for 150 miles, emptying into the St. Lawrence River at Montreal. The total length of the river is about 700 miles and it drains an area of 56,000 square miles.

In the 505 miles of its course from the source to the city of Ottawa, the river repeatedly widens out into long, shallow lakes, which form a series of steps from the Barriere Lakes, 1,100 feet above sea level, to Ottawa, where the elevation is 140 feet. The stretches between the lakes are steep and are broken by falls and rapids, the greatest drop being 80 feet, in the 15 miles between Lakes Timiskaming and Quinze.

Daily measurements of the discharge at Ottawa have been made since 1844, and show that the yearly mean since that date is 55,464 second-feet, the maximum average annual discharge being 68,584 second-feet, and the minimum, 35,583 second-feet. The maximum average discharge for 40 days in 60 years was 158,900 second-feet. The minimum recorded discharge was 25,000 second-feet and the maximum 230,000 second-feet.

The general plans for the reservoir system contemplate increasing the storage capacities of the numerous lakes by low concrete dams at their outlets so that the daily flow of the river throughout the year may be kept as near the average of 55,000 second-feet as possible. The first three projects, which are now under construction, on Lakes Timiskaming, Kipawa and Quinze, have a combined capacity of 168,000,000,000 cubic feet. The total cost of these three reservoirs, including surveys and land damages, is estimated at $728,000, or only a little over four dollars per million cubic feet of storage.

These reservoirs, while they are an important part of the proposed Georgian Bay Canal project, are being constructed independently of that plan because of their great benefits in the prevention of flood damage and in the improvement of the river for navigation, for water power and for industrial and domestic supply.

MISSISSIPPI RESERVOIR SYSTEM

The largest artificial reservoir system in the world, except that under construction on the Ottawa River in Canada, is that at the headwaters of the Mississippi River, where the levels of some of the innumerable lakes have been raised by damming up their outlets and enormous storage capacity created at very small cost. These reservoirs were first reported upon officially by Gen. G. K. Warren in 1870, and the investigations showed a total available storage in the States of Minnesota and Wisconsin of 174,000,000,000 cubic feet. Detailed surveys followed, and actual construction began in 1881. The combined capacity of the five reservoirs constructed is 93,400,000,000 cubic feet and their total cost was about $750,000, or only about eight dollars per mil-

lion cubic feet of storage. The dams were originally timber cribs, but have recently been rebuilt of concrete. The remainder of the available storage reservoirs have never been constructed, but if they were, an eminent authority states that they would be "sufficient to control absolutely the floods of the Mississippi for a long distance below St. Paul, and to improve the navigation of the upper river very materially, while their value for industrial purposes is almost beyond estimate."

APPENDIX No. 6.

PREVIOUS PAPERS AND REPORTS.

The purpose of this chapter is to briefly summarize the main features of some of the principal papers and reports upon floods and proposed methods of flood relief in the United States. Included with these papers and reports, as of special interest in connection with the Report of the Flood Commission, are the records of several actions of the Chamber of Commerce of Pittsburgh, reports upon several conferences at Washington, and a reprint, in full, of the Newlands Bill.

PAPERS

THE MISSISSIPPI AND OHIO RIVERS.

Charles Ellet, Jr., C. E. (1853.)

Mr. Charles Ellet, Jr., a civil engineer of note, wrote a paper, which appeared in the transactions of the Smithsonian Institution in 1849, upon the subject of "The Physical Geography of the Mississippi Valley," in which he advanced the idea of the improvement of the Mississippi and Ohio rivers by means of artificial storage reservoirs. In 1853, a book by the same author was published which voluminously gives these plans for river remedial measures. The views expressed in this book were originally presented in a report by Mr. Ellet to the War Department under an Act of Congress.

The plan proposes levee construction along the Mississippi River, supplemented by control of the flood stages by reservoirs. The thought is expressed that while levee construction may bring about partial relief more speedily, the fundamental method of treating the whole matter is by storage reservoirs, for the purpose not only of preventing the damaging flood crests from reaching the communities along the main part of the principal streams, but of properly conserving the water for the benefit of navigation and, incidentally, providing a considerable amount of water power.

Mr. Ellet maintained that reservoir sites should first be sought on the tributaries of the Allegheny and Monongahela Rivers, as well as on other tributaries of the Ohio; that reservoirs ought to be constructed wherever it is practicable to find appropriate sites; that these impounding basins should be made large enough to receive and retain the flood water of the tributaries and release it when the supply is needed for navigation; and that the value of the then existing commerce would justify the cost.

In discussing the application of the reservoir scheme, the report includes a number of interesting tables and other matter, showing capacities, possible reduced flood stages, and the increase in the low-water stage that could be obtained during the summer months.

PRACTICAL VIEWS ON THE PROPOSED IMPROVEMENT OF THE OHIO RIVER.

W. Milnor Roberts, C. E. (1857-58.)

This paper, published in the Journal of the Franklin Institute, 1857-58, devotes considerable space to a discussion of the idea that the application of the reservoir plan originated by Mr. Ellet is impracticable, and that the physical conditions are not favorable for finding suitable storage. Mr. Roberts says:

"My own careful investigations of the subject of controlling the floods of the Ohio by means of artificial reservoirs, which were made in 1857, satisfied my mind conclusively that such control by any human means attainable within the practicable limits of cost is impossible. I will not, therefore, in this report devote any space to the consideration of the reservoir plan as a means of controlling the floods of the Ohio River. My present attention will be turned wholly to its consideration as a means of effecting a perennial flow in the natural channel of the river sufficient to make a navigation six feet deep at all ordinary periods of low water, and not less than five feet deep at a period of extreme drought. * * *

"Of the reservoir plan of Mr. Ellet it may be said: First: As a means of regulating the floods of the Ohio River so as to confine them to an equable flow or any practical approach thereto it is impracticable. Secondly: As a means of affording in low-water seasons a constant flow of five to six feet depth in the natural river channels, while the plan is not really impracticable, it will necessarily be accompanied by very serious difficulties in its practical accomplishment, besides great cost in construction, and a heavy annual expense for its management. I have presented certain data which afford an approximate or rough estimate of the probable cost, although accuracy cannot be obtained without an extensive system of special surveys. But the probable or possible error of estimate would not be sufficient to affect essentially a fair consideration of the plan as compared with other plans.

"The cost of managing, operating, repairing, and maintaining an extensive system of reservoirs, must of course depend upon circumstances. A few large reservoirs or gigantic river pools constructed on the main streams, (if admissible now), would be cheaper to manage and operate than a large number of scattered isolated reservoirs on the tributaries located over an area of many thousand square miles of territory, though the idea that such very high dams, having elevations of from 60 to 100 feet, can be made available for two distinct and different purposes, namely, for reservoir use and for slackwater navigation, is certainly fallacious."

The cost of the necessary number of reservoirs, it is thought, will not be less than $60,000,000, which is considered prohibitive and not in keeping with the benefits to be obtained.

IMPROVEMENT OF THE OHIO RIVER.

Review of the "Practical Views" of W. Milnor Roberts.

By Elwood Morris, C. E. (1857.)

This paper, published in the Journal of the Franklin Institute, in the year 1857, bears almost entirely upon the reservoir proposition of Mr. Ellet and expresses agreement with the feasibility of the scheme. Mr. Morris states:

"The writer, on the other hand, frankly avows, that having closely studied this subject, and being personally familiar with the Ohio River, he has become strongly impressed with the vast superiority of the system of reservoirs proposed by Charles Ellet, Jr., Esq., C. E., and fully satisfied that an accurate survey alone, is all that is necessary to find adequate sites for reservoirs, and to demonstrate both the practicability of the plan and its pre-eminence over all others. * * * *No discussion will obviate the necessity of a suitable survey.*" * * *

Mr. Morris considers that adequate reservoirs may be found upon the tributaries and that no obstructions whatever need be created on the main streams. He considers that the plans most worthy of attention are: 1, reservoirs; 2, slackwater.

It was admitted that adequate data were lacking for accurate estimates as to capacities and costs, also as to the exact benefits to be derived, but it was thought that the principle was sound and beneficial as a whole.

REPORT ON IMPROVEMENT OF OHIO RIVER.

By Maj. William E. Merrill, Corps of Engineers, U. S. Army.

To Chief of Engineers, September 1, 1873.

In reporting on the improvement of the upper Ohio River, Major Merrill points out that the great difficulty is the lack of water, which he states could not be overcome by dredging alone, but could be remedied by securing a great additional amount of water. He points out the impracticability of obtaining water from Lake Erie either by a canal, which would have to enter the Ohio too far down stream; by storing water in Lake Chautauqua, which would not provide sufficient catchment area or storage; or by pumping into Lake Chautauqua from Lake Erie, which would be too costly.

He then states that there are but two plans that offer any prospect of feasibility:

"One is to retain surplus water by huge reservoirs on the upper tributaries, preserving an unobstructed channel, and the other is to retain a sufficient depth for navigation by locks and dams, thus making shallow reservoirs in the main river."

With regard to the reservoir plan, Major Merrill refers to the paper of Mr. W. Milnor Roberts and gives a summary of the latter's objections to the reservoir system. Major Merrill agrees with the objections and favors the slackwater system, the advantages of which, as compared with the reservoir system, he states to be as follows:

"1. It has long been tried and is now in use on the Monongahela, where it meets the demands of the same commerce that navigates the Ohio.

"2. There are no great hazards connected with the system, as the dams are low and the destruction of one will not necessarily injure the one next below.

"3. It is known positively that locks and dams can be built that will fully answer their purpose, and their cost can be determined beforehand with very fair accuracy.

"4. There would be no damages from overflow, or destruction of property of any kind.

"5. No special care is needed in the use of the slackwater system. The pools are themselves reservoirs containing the minimum amount of water needed and at the exact place where it is to be used.

"6. The cost of this system would probably be less than the other.

"7. The pools would make excellent harbors for all river craft, an improvement that is greatly needed at the large cities, especially at Pittsburgh."

EXAMINATION OF RESERVOIR SITES IN WYOMING AND COLORADO.

Report of Lieut. Col. H. M. Chittenden.

Printed in House Doc. No. 141, 59th Congress, 2nd Session, 1897.

This report treats of reservoir sites in the arid regions and discusses the various types of dam construction and the conditions best suited to each. After special consideration of various reservoir sites, the author passes to a general discussion of reservoirs and their relation to stream-flow. He points out that "the ideal stream would be one in which the flow should be uniform from one year's end to the other, or, if not uniform, varying directly with the magnitude of the uses to which it is put." He goes on to state that not only is stream-flow subject to wide fluctuations, but also "these irregularities of flow have no economical relation to commercial or other uses of the stream." When the streams are most needed for navigation and other purposes their flow is least. Furthermore, when the streams are at their highest, enormous damages from floods result.

Although the natural way to prevent these undesirable conditions of stream-flow would seem to be, the author states, to remove the cause, almost all measures of relief

"look only to the palliation of results, and leave the cause untouched. River channels are dredged out in low water, and levees are built to protect from floods in high water. Scarcely anywhere is the effort made to prevent either high or low water. It would naturally follow that, if great evils result from the variable flow of streams, the primary and fundamental object of the engineer who is called upon to correct them would be to make this flow uniform. The agencies employed for this purpose are called reservoirs."

The author then discusses the effect of natural storage on the flow of streams and shows the conditions as to regularity of flow existing on the basins of certain large rivers in various parts of the world, where large percentages of drainage area are taken up by lakes, laying particular stress on the ideal conditions of flow existing in the St. Lawrence River on account of the Great Lakes. He then passes to a discussion of artificial reservoirs then constructed, treating principally of the huge projects on the Volga and Msta Rivers in Russia, and at the headwaters of the Mississippi River in the United States.

Under the next heading, "Reservoirs and Flood Prevention," the author discusses the action of reservoirs in controlling floods. He states that "every reservoir built

along the course of a stream is, to some degree, a protection against floods in the valley below." He points out that even if a reservoir is full when a flood comes, it still moderates the flow of the stream below, because of the additional storage furnished by the increase in capacity due to the depth over the spillway required to discharge the maximum flood. He states that "this is a very important feature of reservoir action, even where the capacity of the reservoir is not sufficient entirely to prevent the flood." He points out, however, that the retardation of a flood on a given tributary in a reservoir of insufficient capacity may operate to increase the height of the flood in the main stream by bringing two flood waves in conjunction, which under natural conditions would have arrived at different times.

The author notes that flood control and industrial use are not entirely compatible objects, and that if reservoirs were built with such a combination in mind, only part of the capacity could be relied upon for each purpose. He states that, at the time of his report, few reservoirs, if any, had been built for the exclusive purpose of flood prevention, although there were numerous examples where this had been an important consideration in their construction. A full discussion of what has been done in this respect in foreign countries up to the present date has already been given in Appendix No. 5. The investigations of the French engineers after the floods of 1856, which were so destructive on the French rivers, are also discussed at length. The results of these investigations have likewise been described in Appendix No. 5, although the conclusions there drawn from these investigations, and their application to the conditions at Pittsburgh, differ from the opinions of the author of the paper now under discussion.

In closing this section of his report the author emphasizes his opinion that "it is the *cost,* not the physical difficulties, which stands in the way." He says, "it may be stated that as a general rule a sufficient amount of storage can be artificially created in the valley of any stream to rob its floods of their destructive character; but it is equally true that the benefits to be gained will not ordinarily justify the cost." The principal reason for this, in the mind of the author, is that floods happen only occasionally and that "every reservoir built for the purpose of flood protection alone would mean the dedication of so much land to a condition of permanent overflow in order that three or four times as much might be redeemed from occasional overflow." The author fails at this point to take into consideration the relative values of the land overflowed.

The author closes this discussion with the conclusion that "the construction of reservoirs for flood protection is not, therefore, to be expected, except where the reservoir is to serve some other purpose as well." For this reason he believes flood control by storage reservoirs is not likely to be carried out in a large way, because a system of reservoirs would be required. For flood protection on a relatively small scale, however, he believes that "reservoirs will undoubtedly continue to be built, particularly where they serve other purposes as well."

The author continues his paper under the heading, "The Floods of the Mississippi and the Missouri," and refers to previous papers and reports upon the control of the floods in these rivers by means of storage reservoirs. In this connection, after stating that "The great controlling element, in fact, in all the lower river floods is the Ohio River," he continues as follows:

"The magnitude of these floods also depends very largely upon fortuitous combinations of the floods in its tributaries. No single flood from any one of these tributaries, except the Ohio, can produce serious consequences in the main river. But if two or more of them discharge excessive floods in the main stream simultaneously, then it is that great disasters follow. * * *

"It is apparent, therefore, that a reservoir system which should exercise any appreciable influence on the lower river floods must embrace the three great upper tributaries, and particularly the Ohio. What the magnitude of the storage required would have to be may be inferred from the fact that the total discharge of the Mississippi at Cairo above the bankful stage, during the late flood, was 2,368,000,000,000 cubic feet, or 4,250 square miles 20 feet deep, the assumed average depth of reservoirs. * * *

"While it might seem at first thought that this amount of storage could be found, still it would be very difficult to find it. Particularly on the upper Ohio and its southern tributaries favorable sites are understood to be of rare occurrence. * * * The ease with which the writer was able to find storage amounting to 11,000,000,000 cubic feet in the State of Ohio at the very headwaters of streams along the divide between Lake Erie and the Ohio convinced him that the natural facilities for storage are rather greater than is commonly supposed."*

FLOODS AND MEANS OF THEIR PREVENTION IN OUR WESTERN RIVERS.

By T. P. Roberts, U. S. Assistant Engineer.

Proceedings of the Engineers' Society of Western Pennsylvania, July, 1907.

This paper advocates the raising of the flood-overflowed area and the building of walls along the rivers in Pittsburgh for the purpose of flood protection. In this connection the paper does not seem to take into consideration the fact that from such protection alone, practically no other benefits would be derived, and that flood reduction by reservoirs would largely reduce and simplify local measures. It is stated that flood prevention by storage reservoirs has certain advantages, but the probability of finding adequate storage is thought to be slight. It is admitted that a limited amount of control could be secured by this means, but as full control is not possible, the scheme may not be advisable. The opinion is expressed that deforestation has practically no influence upon stream-flow.

In the discussion which followed this paper, issue was taken with the author by members of the society, notably by Mr. Morris Knowles, Mr. Emil Swensson and Mr. E. K. Morse.

Mr. Knowles urged that broad consideration be given a matter of such great importance and that satisfactory conclusions could not be reached without extensive investigations and surveys. With regard to remedial measures, he expressed the opinion that adequate surveys would disclose that a considerable number of feasible reservoir sites could be obtained, and drew the following conclusions:

"That we should have a broader conception of the whole problem and not a selfish consideration for one place; that there is good in both methods suggested; that there are many additional reasons for constructing reservoirs other than the desire simply to diminish flood heights; that a careful survey and study is the only way to properly and finally solve the problem; that this opportunity should be used to so agitate and prepare the public mind that funds for this purpose can be obtained. It is a worthy object in which the Engineers' Society and other civic organizations can unite in a strong effort."

Mr. Swensson, in discussing the matter of storage reservoirs for flood control, considered this the best means for the regulation of the streams, for the reason that it would not only prevent the damaging flood crests from reaching the many communities along the valleys, but would conserve water which could be used to the benefit of navigation and general supply during the low stages of the summer months. He was also of the opinion that even if the reservoir system was not feasible for completely doing away with flood troubles, it would still be possible to secure enough capacity in the aggregate to materially reduce flood heights and damages. The opinion was given that with an adequate amount of reservoir control, construction of walls or filling up of low portions of the city would be considerably simplified on account of the reduction in flood heights.

The idea is expressed that the forests have considerable effect upon stream-flow,

*"See report on Ohio Canal surveys, in 1895, House Doc. No. 278, Fifty-fourth Congress, first session, p. 56; printed also in Annual Report of the Chief of Engineers for 1896, part 5, p. 2973 et seq."

and that while the process of building up deforested areas is a slow one, this is not a good reason for discouraging reforestation.

The following may be quoted from Mr. Swensson's remarks:

"Thus we see that it is not a question of controlling and regulating the flood waters of our rivers solely by one or the other of the possible methods, but rather a combination of all of them, resulting in more or less complete control and regulation, depending upon the extent to which conditions and our means permit us to employ such methods. * * *

"This matter is so large and affects so many communities and so many interests aside from Pittsburgh itself that the first remedies should be inaugurated by the general government, when it becomes easier for the communities to protect themselves against whatever remains of our floods."

Mr. Morse expressed the idea, based upon his observations in the mountains, that the denuding of the country generally resulted in the drying-up of the hillsides and material effect upon the flow of the streams. Reference is made to encroachments upon the bed of the rivers and to the fact that this has caused considerable scouring and deepening of the channel, and thereby necessitated a large amount of riprap protection around the piers, which would not otherwise be required.

RELATION OF WATER CONSERVATION TO FLOOD PREVENTION AND NAVIGATION IN OHIO RIVER.

By M. O. Leighton, Chief Hydrographer, U. S. Geological Survey. (1908.)

This paper was submitted by Mr. Leighton to the Inland Waterways Commission and appears in the 1908 report of that Commission. The paper is of much value in the way of exhibiting the possibilities of reservoir storage in the Ohio Basin for flood prevention and resultant benefits to navigation. It is mentioned that the general idea of reservoir control is not a new one, as it was proposed by a British Engineer, as early as 1800, and in this country by Mr. Charles Ellet, Jr., about 60 years ago. Reference is made to the adverse criticism in a report made in 1857 by Mr. W. Milnor Roberts and in another of much the same character, made in 1873 by Maj. Wm. E. Merrill, Corps of Engineers, both of which have already been described in this chapter. These engineers seem to consider that adequate storage is not obtainable and that, even if it were, it would be too costly, and successful manipulation of the system questionable. Attention is called to the fact that after the general scheme was brought forth adverse criticisms have been made with arguments and figures based upon insufficient data, and in many cases with no actual surveys.

In introducing the subject it is said by Mr. Leighton:

"This report will be confined to a statement of possibilities. There will be no attempt to prescribe methods for treatment of each local modifying condition that will be encountered in the prosecution of the plan here proposed. Such features are merely collateral, and their proper disposition is a matter of ordinary engineering. It is not expected that the facts here set forth will refute all the objections made in past years to the conservation scheme. Such, indeed, is not the object. The paper will have served its purpose if it demonstrates that the plans proposed have so many features of promise that it would be a grave mistake to recommend the permanent adoption of a governmental policy that did not recognize the possibilities and provide for a further and more minute investigation of them.

"Briefly stated, the contentions are as follows:

"First. That the logical way to control a river is to control the sources of its water supply.

"Second. That in nearly all of the rivers of the United States such control can readily be effected by the construction of storage reservoirs.

"Third. That the way to prevent floods is to use these reservoirs to catch and temporarily hold the flood waters, so that they will not descend upon the lower valleys in so large unit volume.

"Fourth. That in the majority of cases the improper and illogical way to attempt the control of floods is to endeavor to confine the rivers between high and expensive levees.

"Fifth. That except along those portions of river channels that are too steep for open navigation, the proper way to maintain navigable depth at the low-water season is to provide, if possible, for the intelligent release of stored water.

"Sixth. That canalization of rivers should be the resort only along those portions of the channel too steep for open navigation or in the tributary basins of which sufficient flood water cannot be stored to maintain navigable depth at low water; further, that when such results may be de-

rived from storage reservoirs, canalization is disproportionately expensive in maintenance and the money so expended might be used for more useful purposes in the uplands.

"Seventh. That, while the first cost of the proposed conservation system will be large, the burden will be widely distributed over a series of years necessary to complete the construction.

"Eighth. That the ultimate cost will appear nominal when compared with the enormous benefits conferred, these benefits being applied to water power and to irrigation, as well as to flood prevention and navigation."

The author of the paper considers that the cost of the reservoir system would be small compared with the benefits derived by flood prevention and river regulation, including aid to the slackwater project, and that the successful manipulation of the system could be readily accomplished.

It is further said:

"It will be appreciated on examination of this paper that the region considered does not cover the entire basin. Therefore this presentation cannot do entire justice to the situation. Whatever results may appear to be claimed as arising from the construction of these reservoirs with reference to the effects of floods and the maintenance of low-water navigation on the Ohio, they do not represent the total possibilities of the region, for, were surveys available on all the basins, it is manifest that far greater storage facilities would be shown to be available. Therefore the maximum effect of conservation would be much greater than shown in the following pages.

"It will be helpful now to consider an objection that is frequently made to the use of storage reservoirs for flood prevention purposes, viz., that there is no way of predicting when floods may come, and it would be certain that a flood would descend on the reservoirs when they were filled to overflowing with the run-off from a previous flood. * * * It will be noted in subsequent pages that the extent of drainage area that can be conserved by various reservoirs has been determined. The reservoirs will hold the entire year's run-off from a stated area, or, in other words, if the gates of the reservoirs were allowed to remain closed for an entire year the reservoirs would retain all the water flowing from that territory for the entire period. Supposing now that two floods should descend into the Ohio River, as they did in January and March, 1907. The second flood could not descend on full reservoirs because the capacity of the reservoirs is sufficient to hold them both. We have, for example, on the Monongahela storage facilities of capacity sufficient to conserve the run-off of 38 per cent of the drainage area.

"Therefore, according to the adjusted capacities stated in the following pages, this per cent of the Monongahela drainage area could be entirely cut off from the Ohio Valley for the period of one year. Of course, this estimate is based on the records of mean flow, as shown by observations extending over a series of years. There is considerable variation from one year to another, so that if the reservoirs actually remain closed there are years in which the accumulation of water would more than fill them and still other years in which the accumulation of water would not suffice to fill them. But the point is that this great capacity furnishes a wide margin on which to work. The two floods of the spring of 1907, for example, would not fill these reservoirs, but, assuming that they remain closed for the entire year, it is possible that the entire year's run-off would more than fill them. But, with this wide margin of time, covering, indeed, a low-water season, when the water would be needed in the Ohio, there is ample time to draw off the water and prepare the reservoirs for subsequent floods. Therefore, the criticism that floods might descend upon reservoirs already filled is based on the hypothesis that the reservoirs are small and their capacity is not commensurate with the size of the basins, whereas, in point of fact, they are sufficiently large for flood prevention. The whole matter therefore comes down to intelligent manipulation, with margins of safety so wide that only the most flagrant stupidity could result in any misfortunate circumstance.

"A further question now to be discussed is, How are we going to manipulate the reservoirs above which there is a large drainage area when their capacity is only sufficient to hold a portion of the flood descending from that area? A glance at the tables in subsequent pages will show that there are many such. This is a mere matter of intelligent manipulation. We will assume, for example, that there is, above a certain reservoir, a drainage area of 100 square miles, while the reservoir itself has a capacity sufficient to conserve the run-off from only 50 square miles. This does not make it necessary that the run-off from the 100 square miles shall come down and overwhelm the 50-square mile reservoir. The fact should be kept in mind that this reservoir is to conserve the drainage from only 50 square miles and therefore as fast as the flow comes down into the reservoir one-half of it should be released through the gates. The release of one-half of the water may readily be accomplished by adjusting the size of the openings in the reservoir gates."

It is pointed out that all floods on the Ohio do not have a common origin; at times they arise in the upper part of the river, and by the time they have reached the lower portion have become so flattened out that they cause no damage or apprehension. Records show that the floods of the Ohio Basin never occur over the entire area at one time, as so far only one-fourth or one-third of the total area has been involved in any one flood. These studies indicate that about 25 per cent of the drainage area above Pittsburgh may be controlled by storage. A table is given which shows that the great

flood of March, 1907, would have been reduced, at the city, by the proposed storage, to a height of about 5.5 feet above the danger line, instead of 13.5 feet, which actually occurred. The estimated reduction at other points, by proper operation of the system, would be as follows: Parkersburg, W. Va., to below danger line; Cincinnati, Ohio, practically to danger line.

Attention is called to the fact that many of the reservoir sites, particularly above Pittsburgh, would be in the upland, in isolated parts of the valleys, where land values and developments are of comparatively small consequence. Data are not available for arriving at exact results for reservoir control, but it is unquestionably thought that sufficient were at hand, at the time, to reveal the fact that practically all floods can be reduced to the danger line at Pittsburgh and at points along the greater part of the Ohio River.

The cost of the system of reservoirs proposed by the author is arrived at by a study of the cost of 97 projects already constructed in various parts of the world, which he groups according to capacities. On this basis he arrives at the estimates of cost shown in the following table:

NUMBER OF RESERVOIRS	CAPACITY IN MILLIONS OF CUBIC FEET	ESTIMATED COST
2	500 to 1,000	$ 1,050,000
52	1,000 to 10,000	53,784,000
15	10,000 to 20,000	12,545,000
31	Over 20,000	57,840,000
100		$125,219,000

It is noted that the greater the capacity of any reservoir the smaller the cost per unit capacity. It is commented that an important feature to be taken into consideration is that the value of any project is not determined by the amount of money used in its construction, but by the final utility of the project.

The conclusions are as follows:

"In the foregoing pages the effect of conservation reservoirs in reducing the height of floods at numerous points along the Ohio, from Pittsburgh to Cairo, has been reviewed. In making the computations of such effects, certain legitimate allowances favorable to the conservation scheme have purposely been omitted. The test of the reservoirs has been made without giving them the advantage of these allowances in the computations. Occasional reference has been made to them in the text. It has been necessary to include rivers on which no information concerning conservation possibilities is obtainable, and other rivers concerning which such information is not complete. Advantage has not been taken in the computations of the fact that the proposed reservoirs will conserve the torrential flow from each basin and leave unregulated the lower and more moderate portions. The figures have been based solely on proportionate areas, conserved and unconserved. All these disadvantages have been accepted freely and the test has been applied to the conditions arising in two floods along the Ohio, the greatest, with one exception, in a quarter of a century. What are the results?

"It has been shown that the flood height in all cases would be either reduced below the danger line or would exceed the danger line by so small an amount that the use of any one of the allowances above mentioned would give complete abatement throughout the length of the river. It is impossible to draw any other conclusion from the data presented. The situation merits further consideration and examination as a part of the proposed government policy with reference to inland waters."

In speaking of the damage caused by the January and March floods of 1907, it is estimated that this amounted to more than $100,000,000 in the Ohio Valley.

The benefits to navigation by a reservoir system will be of the utmost value and it is the idea that on account of the increased flow obtained from the conserved water, a number of locks in the contemplated government system may not be necessary, along favorable reaches of the streams. Regarding the possibilities of water power development, the author is of the opinion that a considerable amount would be made available.

THE APPLICATION OF THE RESERVOIR SYSTEM TO THE IMPROVEMENT OF THE OHIO RIVER.

By Capt. Wm. D. Connor, Corps of Engineers, U. S. Army.
Engineering News, Vol. 59, No. 24, June, 1908.

In opening this paper, the author refers to the previous advocation of storage reservoirs for the improvement of the River Severn, in England, in 1800, and to three of the principal papers on the improvement of the Ohio by means of storage reservoirs. He speaks briefly of naturally conserved rivers and their regularity of flow. He states that there are only four large rivers in the world on which artificial reservoirs have been constructed for the purpose of storing flood waters, the Mississippi, the Volga and Msta, and the Nile. We find in Appendix No. 5 that there are others.

The objects of the reservoir system are divided by the author into three parts, flood protection, assistance to navigation and water power development. He believes that "there is no question but that today its relation to navigability is the most important test that must be applied to the system in discussing its practicability." He recognizes the fact that the possibilities of enormous water power development have added an important argument in favor of the construction of storage reservoirs for flood control, but believes that the figures that some writers have arrived at, as to the income from this source, are too great.

In discussing the proper agent for constructing reservoirs, he expresses his opinion that the Federal Government should do this work, and believes that if it should be found feasible and practicable, the necessary authority and funds would be provided. With regard to the cost he believes "a great initial cost is today no cause for rejection for in case the results to be obtained are commensurate with the amount of money to be expended the plan is sure to be adopted." Like Col. Chittenden and Col. Newcomer, he believes, however, that the cost would not be warranted by the benefits to be derived.

From this point on, the paper is devoted to a discussion of Mr. Leighton's paper on a similar subject. He expresses doubt as to the accuracy of Mr. Leighton's streamflow data, as to the practicability of the reservoir sites, as to the figures for cost, and as to the advantages of the reservoir system. The author expresses the opinion that even if floods were kept within the banks of the Ohio, the floods on the Mississippi would continue and the levee system would still be necessary. He claims that the most damage done by the Ohio River floods is in the Mississippi below Cairo. It is also true that the most damage done in the Mississippi below Cairo is by the Ohio floods. He makes no mention of the fact that if the floods during 1907 had been kept within the banks of the Ohio, $100,000,000 damages along that river would have been avoided.

He goes on to say, further, that even if the reservoir scheme would do all that is claimed for it, its impracticability would prevent its adoption. The scheme is believed by the author to be impracticable, principally because of the cost. He believes that not only would the damages be greater than as figured by Mr. Leighton, because of developments in the valleys selected as available for reservoir sites, but that the cost of the dams would also be considerably greater. He also feels apprehensive as to the safety of the dams, although numerous similar dams are being built for other purposes all over the world every year. Furthermore, he anticipates that the completion of the system of reservoirs, proposed by Mr. Leighton, would be several generations hence, whereas uninterrupted navigation on the Ohio is desired by the public within a few years.

The author also apprehends that the reservoirs may be filled up by silt. The streams on which storage is considered, however, at least those above Pittsburgh, are not large

carriers of silt, and calculations for similar streams have shown that it would take hundreds of years to fill them to any considerable depth.

With regard to the advantages claimed for the reservoir system, the author says of flood protection that "the advantages of a completely conserved river as a means of flood protection are admitted and need no elaboration, but even the physical practicability of this has yet to be conclusively established."

With regard to the benefits to navigation, the author does not believe that the Ohio River could be improved and made entirely navigable by means of storage reservoirs alone, but he states that "no one will question the fact that the reservoirs would aid in increasing the depth of water to a certain extent in the upper part of the river." On this same subject the author writes:

"There is no doubt but that any system of reservoirs would give an increased depth and would improve the river to a certain extent, but just how much the river would be improved will depend upon how many reservoirs can be actually constructed and what their total capacity will be, taken in consideration with the low-water stage at various points along the Ohio River. If the advantages of the reservoir system are found to outweigh the disadvantages, its effect upon navigation should be studied and utilized to the full extent in the improvement of the river."

It is interesting, in this connection, to refer the reader to Chapters IX and X of this report, where the improvement of the flow and the resulting benefits to navigation by reservoirs on the drainage area above Pittsburgh are discussed.

With regard to water power and revenue therefrom, Capt. Connor is convinced that an enormous amount of power could be developed, but that the revenue to be derived therefrom has been largely over-estimated. The author believes that the interests of flood protection, navigation and power could not be served by the same reservoir, although he admits that "even for flood protection a certain amount of water might be kept in the reservoir, and the power interests might be temporarily satisfied with less than a uniform rate the year round."

In closing, the author expresses the belief "that the reservoir system for flood protection is theoretically possible * * *; that it is possible for it to improve the channel depths to a certain extent * * *; that a great amount of power can be developed and ultimately sold at a profit." He does not believe, however, that the reservoir system would be sufficient in itself to completely improve the Ohio River.

ENGINEERING NEWS.

June 11, 1908.

In an editorial appearing in this periodical, reference is made to the above-described paper of Mr. Leighton and to the criticisms of this paper by Capt. Connor, U. S. Engineer Corps. Reference is also made to Mr. Horton's article bearing upon the effect of the Ohio River reservoir project on the floods of the lower Mississippi. "Engineering News" agrees with Mr. Leighton that the reservoir system would be of immense benefit in the way of flood protection, aid to navigation, etc., but that there would still be need for considerable lock and dam construction on the Ohio and its tributaries. "Each is needed to supplement the other," and it is right to place flood protection as the main purpose of the reservoir system and the benefit to navigation as secondary. The damage caused by the floods is annually becoming greater, with an increasing tendency in height and frequency.

"If, then, at a cost not too great for construction work and land damages, a system of reservoirs can be made to supplement the protection furnished by dikes and levees, to help the navigation conditions as well, and to furnish also a revenue through the development of water power, it is surely worth careful consideration at least.

"In the study which we have given to the reservoir system, it has seemed to us that the wisest course would be to test its possibilities first by investigation of a part of the system proposed. If the reservoir system can be made a practical success for any part of the Ohio River, it is on the Allegheny and Monongahela Rivers which join to form the Ohio. Topographical and geological conditions for economical reservoir construction would be as favorable certainly as anywhere in the Ohio Basin, while the benefits to be gained are greater than for an equal amount of work anywhere else. The cities of Pittsburgh and Allegheny have a greater stake in flood prevention than any other cities in the country. * * *

"Further than this, the great industrial center at this point has an interest in *the maintenance of the low-water flow* in the Allegheny and Monongahela, that has nowhere received attention. As our readers know, Pittsburgh draws its water supply from the Allegheny River, and while it has just installed a huge filter plant to purify this water, it is highly desirable that the water in the river be in reasonably good condition before filtration."

The editorial continues by calling attention to the great benefits to be derived by the industrial communities from the increased flow during the summer season. Even if the whole system of reservoirs were not carried out it is considered vitally important to the communities along the rivers that at least one or more reservoirs be built in each of the basins above Pittsburgh. It is also urged that it would be well worth while to at least test the feasibility of the reservoir system by making detailed surveys and estimates for reservoirs in the Allegheny and Monongahela Basins, as being the most practicable place to start in the Ohio River Basin. This is the test that the Pittsburgh Flood Commission has applied at a cost of over $100,000.

PROPOSED RESERVOIR SYSTEM IN OHIO RIVER BASIN.

By Lieut. Col. H. C. Newcomer, Corps of Engineers, U. S. Army.
Engineering News, October 8, 1908.

This article is a criticism of the paper by Mr. M. O. Leighton, which first appeared in the report of the Inland Waterways Commission, and has already been outlined in this appendix.

The author is of the opinion that storage reservoirs are of little importance in connection with improving the navigability of rivers. He believes that such improvement is best obtained by locks and dams. This he states to be the universal opinion and practice in European countries, although it will be seen in Appendix No. 5 of this report, that this is not the case at the present time.

The author doubts Mr. Leighton's assumption that the flood discharge would be lessened in the same or even a greater proportion than the percentage of drainage area that is controlled by reservoirs. While great storms are generally widespread and it is improbable that any would occur which would not involve some of the reservoirs, yet so much of the drainage area is uncontrolled, that the author apprehends that a flood might come from this uncontrolled area. At any rate, flood-producing rain storms are not uniformly distributed and might be concentrated on the uncontrolled area, when the percentage of run-off held back would be less than the percentage of drainage area controlled.

The author is of the opinion that foreign engineers do not favor storage reservoirs as a means of flood control, although an examination of Appendix No. 5 of this report will show that reservoirs have been extensively employed for the prevention of floods in portions of Europe, and are more and more coming into use, the purpose of flood control being in many cases combined with those of navigation and power. The lack of suitable sites and the cost have been the principal difficulties encountered by European engineers, and form their chief objections to this method of flood relief.

The author does not agree with Mr. Leighton's figures for the value of the water power that could be made available, and raises the question as to the ownership of

this power, and as to the agent that would receive revenue therefrom. He believes that $5 per horse power per year would be nearer the rental that could be obtained than the $20 used by Mr. Leighton, although it should be added that Mr. Leighton used this figure of $20 as a basis for estimating the *value of* and not the revenue from the power.

The author's chief criticism of Mr. Leighton's paper, however, and his principal reason for considering the reservoir scheme impracticable, is the excessive cost. It is admitted that unquestionably there are great benefits to be derived from a system of reservoirs, that the matter is one of great importance, and that "the system should be built if it can be done at a reasonable cost. This is the vital feature of the problem and the one that generally condemns the system as being impracticable from a financial standpoint." Doubt, however, is expressed as to the possibility of finding adequate reservoir sites on the tributaries, at reasonable cost and commensurate with the benefits to be obtained. Furthermore, the author believes that a satisfactory application of the whole scheme might be found impracticable, because of the above and on account of probable difficulties in the way of proper manipulation of the reservoir system for the uses proposed.

An estimate is given, based upon a rapid reconnoissance, as to the probable cost of certain projects suggested by Mr. Leighton, whose estimates are doubted. It is thought by the author that a limited amount of return may be gained from water power development, but no estimate is made of possible returns in the way of benefits due to flood prevention, aid to navigation, etc. The author states:

> "It appears doubtful, therefore, whether such a plan can be prosecuted on a scale of sufficient magnitude to satisfy the pressing needs either of navigation or of flood protection on large rivers. On the other hand, it seems reasonable to expect that the growing demand for water power development and for water supply systems will lead to the construction of reservoirs in increasing numbers, so that in the course of time their aggregate capacity on any particular drainage area may come to have an appreciable influence on stream flow."

In the Engineering News of November 5, 1908, an answer was made to Col. Newcomer's paper, by Mr. Leighton, who upholds his general proposition as previously set forth.

FORESTS AND RESERVOIRS IN THEIR RELATION TO STREAM-FLOW, WITH PARTICULAR REFERENCE TO NAVIGABLE RIVERS.

Paper by H. M. Chittenden, M. Am. Soc. C. E.
Transactions of Am. Soc. C. E., Vol. LXII., March, 1909.

This is one of the most comprehensive papers upon this subject, and was discussed in detail by a large number of prominent engineers, many of whom differ from the opinions and conclusions of the author. The paper is divided into two parts, the first dealing with the relation of forests to stream-flow, and the second with the relation of reservoirs to stream-flow.

RELATION OF FORESTS TO STREAM-FLOW.

The author discusses this subject under four main headings:

1. Effect of forests upon the run-off from rainfall.
2. Influence of forests upon snow melting.
3. Effect of forests upon precipitation.
4. Prevention of erosion by forests.

After treating the subject at considerable length under the above headings and referring to records and authorities in other countries and in the United States, the author sums up his treatise in the following seven propositions:

"1. The bed of humus and débris that develops under forest cover retains precipitation during the summer season, or moderately dry periods at any time of the year, more effectively than do the soil and crops of deforested areas similarly situated. It acts as a reservoir moderating the run-off from showers and mitigating the severity of freshets, and promotes uniformity of flow at such periods.

"2. The above action fails altogether in periods of prolonged and heavy precipitation, which alone produce great general floods. At such times the forest bed becomes thoroughly saturated, and water falling upon it flows off as readily as from the bare soil. Moreover, the forest storage, not being under control, flows out in swollen streams, and may, and often does, bring the accumulated waters of a series of storms in one part of the watershed upon those of another which may occur several days later; so that, not only does the forest at such times exert no restraining effect upon floods, but, by virtue of the uncontrolled reservoir action, many actually intensify them.

"3. In periods of extreme summer heat forests operate to diminish the run-off, because they absorb almost completely and give off in evaporation ordinary showers which, in the open country, produce a considerable temporary increase in the streams; and therefore, while small springs and rivulets may dry up more than formerly, this is not true of the larger rivers.

"4. The effect of forests upon the run-off resulting from snow-melting is to concentrate it into brief periods, and thereby increase the severity of freshets. This results (a) from the prevention of the formation of drifts, and (b) from the prevention of snow-melting by sun action in the spring, and the retention of the snow blanket until the arrival of hot weather.

"5. Soil erosion does not result from forest cutting in itself, but from cultivation, using that term in a broad sense. The question of preventing such erosion or soil wash is altogether one of dispensing with cultivation or properly controlling it. The natural growth which always follows the destruction of a forest is fully as effective in preventing erosion, and even in retaining run-off, as the natural forest.

"6. As a general proposition, climate, and particularly precipitation, have not been appreciably modified by the progress of settlement and the consequent clearing of land, and there is no sufficient reason, theoretically, why such a result should ensue.

"7. The percentage of annual run-off to rainfall has been slightly increased by deforestation and cultivation."

The author then goes on to state that "if the foregoing propositions are correct they enforce two very important conclusions—one relating to the regulation of our rivers and the other to forestry."

The first of these is "that no aid is to be expected in the control or utilization of our rivers, either for flood prevention, navigation or water power, by any practicable application of forestry."

The second conclusion is that "forestry will be left to work out its own salvation without any reference to the rivers."

This, however, in the opinion of the author, would work no harm to the cause of forestry, for "it stands on a basis of its own, too broad and too sure to require any extraneous aid," namely "the benefit and enjoyment of the people." To make this benefit and enjoyment possible, it is even to the advantage of the forestry work to have it absolutely independent of any connection with waterway development, and promoted solely on the basis of producing trees for human use and enjoyment. Forests need not then be planted and preserved in the rugged and inaccessible mountains, where it has been claimed they are most needed to control run-off, but can be established and maintained in locations convenient for access by the people, instead of being seen only by the solitary hunter or mountaineer.

RELATION OF RESERVOIRS TO STREAM-FLOW.

In this part the author deals only with artificial reservoirs, of which he writes as follows:

"The artificial reservoir is intended to attack this problem at its source. It catches and holds back the water in the near vicinity of its deposition, instead of waiting until it gathers into the rivers, and then building huge bulwarks to contain it there in times of flood. It saves the stored-up supply and gives it out in the low-water season, thereby helping navigation, instead of dredging and otherwise treating the watercourses to increase the low-water depth. It corrects one of the greatest deficiencies of Nature by abolishing inequalities of stream-flow and converting waste into utility. Theoretically, it is the perfect plan."

The author then goes on to say that, practically, however, reservoirs for flood control are not feasible. He excepts the case of the Mississippi reservoirs in Minnesota and Wisconsin, described in Appendix No. 5, on account of the peculiarly favorable sites. Reference is also made to the propositions to control floods on the Sacramento and Kaw Rivers by means of storage reservoirs and to the adverse reports upon these projects.

The remainder of the paper occupies itself mainly with the treatment of the proposition of Mr. M. O. Leighton to control the floods and improve the navigation of the Ohio by means of storage reservoirs. In this discussion he claims that if built at all they must be built primarily for power development, and that it will never be possible to regulate the reservoirs for the maximum benefit of both purposes. He also anticipates that the operation of a system of storage reservoirs would be attended with many difficulties.

The author's principal stress, however, is laid upon the excessive cost of a system of storage reserviors. He claims that the damages caused by the overflow of the lands necessary for the reservoirs would be excessive. It should be noted, however, that he has lost sight of the fact, which still remains true, that many of the proposed reservoirs are located in the very mountains, rugged and inaccessible, and seen only by the solitary hunter or mountaineer, which he has already pointed out as therefore undesirable even for forest reserves. He concludes that "taking everything into consideration on the most liberal basis, it is evident that this system cannot be built for less than $250 per 1,000,000 cu. ft."

The author then goes on to make an estimate as to possible revenue from power development and to compare this with the cost of reservoirs. Considerable space is devoted to a discussion of what income per horsepower per year could be expected and he takes issue with Mr. Leighton's figure of $20, choosing rather to use $5. This comparison of revenue and benefits with costs considers only the revenue to be derived from water power. In fact, the author states that, in his opinion, the basis of any great reservoir system in our country must be industrial use. He does not take into account the annual saving that would come from the prevention of floods and flood damage and from the improvement of the rivers for navigation and water supply.

The paper is concluded with a discussion of the relation of navigation to other uses of rivers and to certain legal obstacles that stand in the way of a broad treatment of our streams.

FLOOD PREVENTION AND PROTECTION.

By Emil Swensson, M. Am. Soc. C. E., Member of Flood Commission.
January, 1909.

This paper was prepared for the Flood Commission by Mr. Swensson, after his return from an extended European trip, during which time he was commissioned by the Chamber of Commerce of Pittsburgh and the Mayor of the City, to make note of flood relief methods as applied in foreign countries.

River engineering is stated as having been a matter of gradual evolution, and is broadly discussed in its many phases, particularly as treated in foreign countries. The idea is expressed that streams are too much thought of, especially in the United States, as simply lines of drainage and not as factors which can be readily made of great economical importance in the general welfare of man. Due to the growth of population and indifference on the part of the public, the streams have become extensively misused by the placing of encroachments in or across the channels, and by the filling out of banks in such manner as to materially reduce the free discharge requirements of

nature. Reference is made to methods of river improvement frequently applied, such as badly placed dykes, slackwater works for navigation, etc., which in themselves have sometimes increased flood heights with disastrous results to property.

In referring to flood remedial measures, the author states that as methods of *protection,* such as walls, dykes, dredging, cut-off channels, etc., have long been in use, his attention was directed chiefly to methods of *prevention,* by storage reservoirs, which were found to be most highly developed in middle Europe. Attention is called to the fact that the experience with local flood protection methods, extending over a century, has proved them to be more and more inefficient, while experience with the newer and more scientific method of prevention has proved it to be of much greater efficiency, utility and economy, benefiting broad areas of the country.

The work is usually conducted under departments of state or commissions, and the duties embrace a complete study of hydrographic, physical and, in fact, all natural conditions of the streams and of the drainage basins. In many of the districts, data as to temperature, rainfall and stream-flow have been in course of collection for more than a century. These records are used as a foundation for the design and operation of works for flood control and stream regulation, a number of which have been successfully employed. Foreign countries have learned that rainwaters are one of the most valuable natural resources and should be conserved whenever possible as one of the great national economies for the welfare of the people.

Many of the new measures are conducted by commissions which not only gather all the data relating to the streams, but design the plans for the improvements, estimate the costs, and proportion the damages and benefits among the people or districts interested.

* * * "The engineering profession has of late turned its attention to the prevention of floods, as well as to protection against floods, especially as in many instances the formerly practiced methods of protection had proven inefficient and too costly, particularly where many communities including large cities were affected. * * * Methods for prevention of floods have the advantage over methods for protection against floods, by reason of their adaptability to combine in them other advantages and utilities for the good of mankind, for instance, supply for navigation and cities, and for water power."

Reference is made to the favorable influence that forests have upon the regulation of stream-flow and in connection with this feature the foreign idea is expressed as follows:

"Such matters have been taught by the forestry department, and the benefits from forestation in matters of run-off is no longer a theory with these people, but an established fact."

PAPER READ AT CONFERENCE OF NATIONAL WATERWAYS COMMISSION WITH FLOOD COMMISSION OF PITTSBURGH, PA., APRIL 17, 1911.

By W. G. Wilkins, M. Am. Soc. C. E., Member of Flood Commission.

The Sub-committee on Flood Prevention of the Engineering Committee of the Flood Commission of Pittsburgh believed that all possible means for the *prevention of floods* as distinguished from local *protection against floods* should be investigated. This branch of the investigation naturally divides itself into the following subdivisions, viz: the effect of (a) Storage Reservoirs, (b) Reforestation.

The sub-committee have made their own investigations as to the effect of storage reservoirs, but the investigations with regard to the forest conditions have been made by the Forest Service of the United States Department of Agriculture and the Department of Forestry of the State of Pennsylvania, acting jointly.

The first investigation in this country as to the possibility of the prevention of floods by the construction of storage reservoirs was made by Charles Ellet, Jr., C. E., for the

War Department of the United States, and his report was published in 1853, in a volume entitled "The Mississippi and Ohio Rivers; Containing Plans for the Protection of the Delta from Inundation; and Investigation of the Practicability and Cost of Improving the Ohio and Other Rivers by Means of Reservoirs." This report was the subject of considerable discussion among engineers at the time it was published, and the discussion has been continued more or less ever since.

Extensive discussion was caused in 1908 by the appearance of a paper prepared as an appendix to the Preliminary Report of the Inland Waterways Commission, by M. O. Leighton, Chief Hydrographer, United States Geological Survey. Mr. Leighton's paper in connection with the subject of reforestation, and its advocation by the United States Department of Forestry, seem to have been the *raison d'être* for a paper read before the American Society of Civil Engineers by H. M. Chittenden, Lieut. Col., Corps of Engineers, U. S. A., entitled "Forests and Reservoirs in their Relation to Stream Flow With Particular Reference to Navigable Rivers," which was extensively discussed by a large number of members of the Society.

Mr. Ellet, in his report, wrote regarding the Mississippi River:

"They who have resisted the power of the river where it has been necessary to construct dams along its entire course (i. e.) *levees* on both shores, will assuredly be able to appreciate how much easier it will be to erect proper dams across the gorges of a mountain, where the reservoirs are already formed, and bounded on every side excepting the small gaps to be closed up.

"It is not the intention now, however, to discuss the proposition which the writer ventures to suggest, in detail. But it is my duty here to say again that it is entirely practicable, for *a cost that will be fully justified* by more than one of the great objects which will be accomplished by this plan to hold in reservoirs surplus water enough to improve the navigation of every navigable stream in the Mississippi Valley, by discharging the excess so retained into the channels when it is needed there, and at the same time, and by the same process, to protect the whole delta, and the borders of every river in it, primary or tributary, from overflow."

Colonel Chittenden in his paper above mentioned, after referring to Ellet's report, wrote:

"The subject has often been considered since, both in private and official investigations. The conclusion has invariably been that, great as the benefits of such a system would be, if in existence, *the cost of bringing it into existence would be out of all proportion to such benefits.*"

Colonel Chittenden also refers in his paper to a report which he made in 1897, "On the Advisability of Building Reservoirs in the Arid Regions" for the purposes of flood control, and in this report he said:

"Every reservoir built for the purpose of flood protection alone, would mean the dedication of so much land to a permanent overflow in order that three or four times as much might be redeemed from occasional overflow. One acre permanently inundated to rescue three or four acres from inundation of a few weeks once in three or four years, and this at great cost, could not be considered a wise proceeding, no matter how practicable it might be from engineering conditions alone. The construction of reservoirs for flood protection is not, therefore, to be expected, except where the reservoirs are to serve other purposes as well."

Criticisms have also been made on Mr. Leighton's report for the reason that the projects and sites which he suggests had not been selected after careful examination on the ground, and that his estimates were not made after actual surveys of the sites had been made, and that the basis of his estimates of cost was deduced from the average cost per million gallons of storage capacity of reservoirs of widely varying capacity and manner of construction.

Colonel Chittenden in the conclusion of his paper, says:

"The part that reservoirs will play in the larger problems of channel improvement and flood control on the great rivers, will be in the nature of an insurance. Every cubic foot of water taken from the crest of a flood, and released when the rivers are the lowest is *pro tanto* a benefit. If the great floods can be cut down by so much as a foot through reservoir storage, it will be an immense gain, and the same will be true if the low water stages can be increased by two or three feet."

The extracts from the report of Colonel Ellet and from the paper of Colonel Chittenden are quoted to show that there are differences of opinion held by engineers as to the advisability of storage reservoirs for the purposes of flood protection and as aids to navigation. No record can be found of any discussion of any project in the United States, based upon actual surveys of the reservoir sites and careful estimates of cost based upon unit prices for the various kinds of work required in the construction, for so large a specific problem as that with which the Pittsburgh Flood Commission has had to deal. The problem with reference to Pittsburgh was of such magnitude that the Engineers' Committee believed that actual surveys of sites available for storage reservoirs should be made, and that enough plans should be made to provide the data for estimates of their cost. The Commission authorized the Engineers' Committee to proceed on this basis, and as will be seen later, forty-three (43) projects were selected on the tributaries of the Allegheny and Monongahela Rivers, thirty-two (32) of which were actually surveyed.

The conditions of the flood prevention problem at Pittsburgh are very different from those which Colonel Chittenden mentions in his report on the advisability of building reservoirs in the arid regions. In the Pittsburgh problem, one of the conditions is practically the same, viz: "the dedication of so much land to a condition of permanent overflow, in order that three or four times as much might be redeemed from occasional overflow," but in the Pittsburgh problem, the *value* of the land dedicated to permanent overflow is insignificant as compared with the *value* of the lands and the improvements on the land which is occasionally overflowed. As will be seen in the Flood Commission's report, if the entire 43 reservoir projects, which have been investigated, were every one built, the entire cost of construction, including the cost of the land inundated by these reservoirs, would be but little more than five times the loss and damage done to Pittsburgh in three floods which occurred within a period of one year and five days, the first in March, 1907, and the third in March, 1908.

There seems to be no difference of opinion among engineers as to the one fact that storage reservoirs will reduce the height of the flood crest to some extent, but there seems to be great diversity of opinion as to whether the benefits derived warrant their cost. In the investigations which the sub-committee on Flood Prevention have made relating to storage reservoirs there were two things which they sought to determine, viz: First, to what extent the flood crest could be reduced by various combinations in the number and location of reservoirs on the tributaries of the Allegheny and Monongahela Rivers; the second, what combinations of the various reservoirs would result in such a reduction of the flood crest, that their cost in comparison with the damage caused by flood would warrant their construction. It will be seen from the results of our investigations, that when the immense damage occasioned to Pittsburgh by floods in the past and which are liable to occur at any time in the future are compared with the cost of the reservoirs, that there can be no question that their construction is fully warranted.

The construction of these reservoirs will not only reduce the damage from floods, but will also serve to maintain a stage of water in the Allegheny River sufficient to enable steamboats to navigate during such times as present conditions frequently show to be too low for navigation purposes. These reservoirs will also serve to aid in the navigation of the Monongahela River, the discharge of which in periods of drought becomes so small, that evaporation, leakage through the dams and the emptying of the locks for the passage of a steamer allows more water to flow from the pool above the

dam than the actual volume of water flowing into it. The discharge at times is so small that flash boards are placed on top of the dams in order to hold the water in the pools. In 1838 the late W. Milnor Roberts, Past President Am. Soc. C. E., then engineer of the Monongahela Navigation Company, stated that in that year all the tributaries of the river between Brownsville and the mouth of the Youghiogheny River, a distance of about 42 miles, were dry at their mouths. His son, Thos. P. Roberts, United States Assistant Engineer at Pittsburgh, states that the same thing occurred in 1895 and in 1908.

As noted in another part of this report, at such times of small discharge, the water becomes so impregnated with acid in the water flowing from coal mines, that great damage is done not only to the boilers of boats on the river, but also boilers in the manufacturing plants along the banks. At such times enough water could be let out of the reservoirs to very largely reduce the percentage of acid, with a corresponding reduction in the damage to boilers.

While these investigations have been made so far as flood prevention is concerned, primarily with regard to the City of Pittsburgh, there can be no question but that the towns on both the Allegheny and Monongahela Rivers above Pittsburgh will also be largely benefited by the reduction in flood height and the improvement of navigation. It is also true that the towns on the Ohio River, below Pittsburgh, will also be benefited by the construction of these reservoirs, which benefit would be largely increased by the construction of similar reservoirs on the tributaries of the Ohio which empty into it below Pittsburgh.

With reference to flood control in the Ohio River by reservoirs on the tributaries emptying into it below Pittsburgh, Colonel Chittenden said on pages 2862-2863 in the Annual Report of the Chief of Engineers for 1898:

"The ease with which the writer was able to find storage amounting to 11,000,000,000 cubic feet in the State of Ohio, at the very head waters of streams along the divide between Lake Erie and the Ohio, convinced him that the natural facilities are rather greater than is commonly supposed."

This one statement alone should, in the opinion of the Flood Commission, be sufficient to warrant the cities and states along the Ohio River, or the National Government, or all three jointly, doing just what the Flood Commission of Pittsburgh have done, viz:—

Investigate the problem by actual surveys, and after making as close estimates as possible of the flood damages and of the cost of storage reservoirs, determine, as we have done, whether the cost is or is not warranted by the benefits derived.

FLOOD OF MARCH, 1907, IN THE SACRAMENTO AND SAN JOAQUIN RIVER BASINS, CALIFORNIA.

By W. B. Clapp and others.

Transactions of Am. Soc. C. E., Vol. LXI, 1908.

This paper, which is of unusual interest, gives a full description of the topographical and drainage features of the river basins and explains the various conditions obtaining at the time of the flood of 1907. The papers include a number of diagrams and tables.

The Sacramento and San Joaquin Valleys are situated in the northern part of California, with respective drainage areas of 27,100 square miles and 18,300 square miles, or a combined area of 45,400 square miles, all of which is directly tributary to the ocean. A large area, 12,600 square miles, situated to the south of the headwaters of the present San Joaquin, called the Lake Basin, was originally a part of the San Joaquin; in late years, however, certain physical conditions so changed that this area

became separated. The City of Sacramento is located on the left bank of the Sacramento River, about 130 miles from the seacoast and about 90 miles above the mouth of the San Joaquin. The chief tributaries of the Sacramento, named in order above the city, are the American, Feather and Pit Rivers, and all have their source in the summit of the Sierras.

A considerable part of the lower San Joaquin Valley and a very large part of the Sacramento Valley are almost annually inundated by the higher floods, and in the floods of the latter named valley, the City of Sacramento is affected, sometimes to serious extent. In reference to the 1907 flood losses, it is said that about 3,000,000 acres of land were completely inundated, resulting in nearly complete destruction of the crops, together with injury to prospective yield. Many miles of costly levees were damaged and had to be rebuilt, and railroads suffered heavily on account of the washing-out of roadbeds, bridges and culverts. It is estimated that the total damage occurring for this flood exceeds $5,000,000.

In regard to some of the contributing causes for floods the following may be quoted:

"1. The steep, barren, and impervious slopes of the mountains and foothills, which result in streams of heavy grades and the rapid delivery of water to the valleys.

"2. The broad, flat valleys, with light grades and sluggish streams.

"3. The limited channel capacity. It is said that some of the trunk channels are not large enough to carry even one-third of the flood flow. Particularly is this true of the Sacramento River. Here the surplus water overflows into the flood basins, the result being either to increase or diminish the stage of the lower course of the river, depending on the volume of water in the flood basins at the beginning of the flood period and the duration of the period.

"4. The common outlet of the two river systems, with large tributaries of each system discharging into trunk streams near this outlet.

"5. The constriction of the flood area in the delta of the two rivers through the reclamation of large areas of overflow land by levees.

"6. The deposition of the debris resulting from hydraulic mining in several tributaries of the Sacramento River, the result of which has been the filling of channels and the reduction of gradients, thereby raising the flood plane several feet.

"7. The tidal and wind action in the delta of the two rivers."

It is understood that hydraulic mining has now ceased in this region, but the debris from these old operations has caused considerable trouble.

"From 1849 to 1880 enormous quantities of debris—sand, gravel, and cobbles, the tailings from hydraulic mining—were deposited in the upper course of several of the streams on the eastern slope of the Sacramento Basin. The volume of this debris in the Yuba River alone has been variously estimated at from 71,000,000 to 700,000,000 cubic yards. At the mouth of the river, near Marysville, it has a depth of 7½ feet; at Dugnens point, 11 miles above the mouth, it has a depth of 26 feet, and at The Narrows, 18 miles above the mouth, it has a depth of 84 feet."

The flood plain of the central portion of the valley is of unusual extent, with the immediate river banks in many places 5 to 20 feet higher than the land on either side, for some distance back from the river. Some of the low lands or troughs of the flood basin are several miles distant from the river channel.

It is said that the flood of 1907 was remarkable, as in the first place it was preceded by a period of heavy precipitation resulting in flood stages, which condition prevailed intermittently for several preceding weeks. The earth was therefore thoroughly saturated and practically all the surface basins which held water were more or less full. This was particularly the case on both sides of the Sacramento River. The precipitation was of extraordinary intensity over the entire drainage area, the storm covering a period of several days, accompanied by a high temperature, resulting in the rapid melting of snow in the higher altitudes. Record-breaking stages obtained on the Sacramento and on its principal tributaries. The mean run-off of the Sacramento Basin, alone, amounted to about 530,000 second-feet, or somewhat more than 22 second-feet per square mile. It

was noted that the combined mean flow from the foothills of the Sacramento and San Joaquin Basins for the four days, from March 18 to 21, was about 732,000 second-feet.

The paper includes a valuable discussion regarding storage reservoirs for control of the floods, which scheme is considered to be closely interwoven with the reclamation of certain parts of the basin by irrigation. It is remarked in this connection that

"any rational system of reclamation for the overflow lands in the Sacramento and San Joaquin Valleys must make provision for passing the peak of the floods rapidly to Suisun Bay. The volume of flood water to be passed in Sacramento Valley, as determined by actual gagings of the flood of March, 1907, largely exceeds all estimates previously used as a basis for the computation of proper channel capacity to carry safely the flood waters of the Sacramento River. Indeed, it may be that the task of rectification and enlargement of channel necessary to pass such floods as that of March, 1907, is so great as to make it economically impossible. In such event, some auxiliary system of flood control would have to be devised. Probably no more effective and easily executed auxiliary system could be found than that of large, regulating storage reservoirs in the mountains. Such reservoirs could be utilized to store water during floods, thereby reducing the peak of the flood in the valley sufficiently to allow the main channel to carry it safely to Suisun Bay.

"The United States Reclamation Service has located the principal reservoir sites in the Sacramento Basin, and has made surveys to determine the capacity and probable cost of most of them. Of the reservoirs surveyed to date, four are in Stony Creek Basin, with a total capacity of 124,100 acre-ft.; two are in Cache Creek Basin, with a total capacity of 176,500 acre-ft.; two are in Puta Creek Basin, with a total capacity of 318,000 acre-ft.; seven are in Feather River Basin, with a total capacity of 775,600 acre-ft.; four are in Pit River Basin, one of which has a capacity of 3,196,000 acre-ft.; and one is on the Upper Sacramento River at Iron Canyon, with a capacity of 226,900 acre-ft. In the San Joaquin Basin no reservoir sites have been located and surveyed yet, although it is probable that the area contains some good ones." * * *

The combined effect of the reservoirs on the Sacramento would reduce the maximum flow by about 86,000 second-feet above the mouth of Stony Creek, 106,000 second-feet above the mouth of the Feather River, and 179,000 second-feet below the mouth of Cache Slough.

THE REDEMPTION OF THE GREAT VALLEY OF CALIFORNIA.

By A. D. Foote, M. Am. Soc. C. E.

This paper, with discussions, appeared in the transactions of the American Society of Civil Engineers, Vol. LXVI, 1910. The author refers to the mishandling of the natural resources in the upper waters and its effect upon the general valley.

During the winter of 1908-09, the first heavy rains fell on the watershed of the American and Yuba Rivers, which resulted in considerable damage, and the paper goes on to say, in part, as follows:

"Few realize what good luck it was for Sacramento City that the flood came down the American first. Had the heavy rains fallen in the northern counties first, the crest of the flood would have reached Sacramento about in time to meet the crest of that from the American River. The levees east of the city would have gone out, and the whole American River, swelled by the back-water from the Sacramento, would have swept the city, a mass of wreckage, drifting toward the Bay. A few of the stronger buildings might have stood, but probably the American River channel would now be in front of the capitol."

Reference is made to the report of the State Engineer for 1907-08, which discusses the apparent antagonism of the different interests in the Great Valley—navigation, flood protection, drainage, irrigation and mining—and claims that work done for navigation alone is fatal to flood protection, because it contracts the drainage channel in order to give depth at low water and thus prevents the free passage of the floods. Works for irrigation alone take water needed for navigation. Mining is stopped, because the debris fills the drainage channels and spreads over the farm lands. Drainage is blocked by the levee system, built for flood protection. The State engineer says, in seeking a remedy: "The first requisite is a unification of purpose and harmony of effort among the various interests involved."

The author refers to the irrigation works in Egypt and considers that the condi-

tions in the Great Valley are similar and that the Egyptian methods might be followed with success in solving the local problem. In speaking of basin irrigation, over the floor of the valley consisting of about 3,000,000 acres, the system is described of dividing the land with dikes into so-called basins and introducing flood water, usually carrying considerable sediment and letting it stand for some time, until the sediment is settled and the water is soaked into the soil, or the surplus drained off through channels, back to the river:

"In this way the flood can be mastered and controlled and made to spread peacefully over the floor of the Great Valley, where it will water and enrich the land, and then pass on to the sea, leaving the certainty of full crops behind it. Contrast this with placing dependence on a precarious rainfall to grow an inferior crop on a deteriorated soil, and unsuccessfully fending off the flood in terror lest it destroy the country."

The paper refers to the fact that it is impossible with the data at hand to arrive at accurate detailed plans of basin irrigation and auxiliary work. It mentions, however, a proposed scheme, in connection with the basin-feeding regulators, consisting of movable dams with locks for slack-water and navigation, and dams or barriers to prevent future washing from the hills into the navigable channel. At times of high floods it is likely to happen that the drainage channels will be taxed beyond their capacity, in which case the river dams will be lowered and the excess passed down into the rivers.

In the discussion of the paper, issue was taken regarding the feasibility of the general plan, as outlined in the paper. It is thought that the navigable depth of the principal parts of the stream is as great now as it has ever been, and it is the idea that even if the works, such as dams, barriers, etc., could be successfully built to stand the wear of the flood waters, they could not be maintained and operated within reasonable cost.

Another thought was that the whole scheme, to give the best results for flood protection of the Great Valley, should be considered as follows:

"1. Straighten and improve the present channels, so as to bring them to their greatest carrying capacity;

"2. Design the levee system on both banks to carry as large a flood as possible 'within banks';

"3. Then use the basin system as a by-pass, to handle unusual floods."

Referring to the carrying of the flood waters upon the lands of the valley, it was considered by an engineer, in criticising the plan, that the silt-bearing characteristic of the stream will cause, by this side diversion, a considerable amount of deposit in the main channel, finally resulting in raising the water plane of the floods. It is stated, however, that as hydraulic mining operations have ceased, there will not be so much heavy sediment carried by the stream, and it is further thought that this evil will gradually correct itself, aided, to a greater or less extent, by restrictive works.

In further discussion it was also thought that the whole matter can only be treated satisfactorily by comprehensive investigations and that:

"It may be advisable for this purpose to create some permanent organization, either under State auspices or under co-operative arrangement between the State and the Federal Government, with sufficient funds for continuous collection of information regarding the stream system, and for the systematic carrying on of a general study of the problem of river treatment, until a well-digested plan shall have been formulated."

In considering the matter of storage reservoirs the following is quoted:

"The extent to which reservoirs in the mountains, if built primarily for irrigation, can be depended on to absorb a portion of the flood crest, is a mooted question, independent even of the lack of certainty which exists as to the presence of suitable foundations for dams reported on and generally assumed as feasible. It cannot be doubted that some of these reservoirs will at times be nearly or entirely full well in advance of the flood reaching its maximum. Reservoiring constitutes one of the many branches of this intricate problem which must be given proper consideration."

REPORTS.

ELMIRA, N. Y. (1890.)

This city is located a few miles north of the Pennsylvania state line, on the Chemung River, a large tributary of the North Branch of the Susquehanna River. The upper waters of the Chemung head in Pennsylvania and New York, and the drainage basin, above Elmira, has an area of about 2,000 square miles. An engineer was engaged by the city authorities to make investigations. The report deals largely with the flood occurring May 31 and June 1, 1889, at which time much of the low land of the city was overflowed, resulting in considerable damage and interruption to business, including the delaying of trains. This flood exceeded the one of 1865 in volume and damage.

It is said that the center of the 1889 storm was situated 10 to 15 miles southwest of Elmira, with a total rainfall of about 10 inches. At Wellsboro, Pa., 36 miles southwest of Elmira, the rainfall measured 9.8 inches, of which 7.5 inches fell between the hours of 9 p. m. of May 31, and 7 a. m. of June 1. The town of Wellsboro is located on the Tioga tributary of the Chemung, about 40 miles north of the City of Williamsport, Pa.

The engineering report states that certain parts of existing dykes and other works, including encroachments along the banks, had much to do with increasing the flood height. The report recommends the removal of a dam and several islands, correction of channel and rebuilding of dykes. Several schemes are proposed, varying in cost from about $400,000 to $700,000. By the improvements proposed it was stated that a considerable area of land would be reclaimed and in addition real estate values increased and the city beautified.

WILLIAMSPORT, PA. (1895.)

The valley of the West Branch of the Susquehanna River has had a number of disastrous floods, resulting in great damage to the City of Williamsport. After the flood of 1894 a citizens' committee was formed, for the purpose of collecting data regarding the damage sustained by the city, and reporting upon the best method and the cost of flood relief.

The general improvement of the West Branch of the Susquehanna was under consideration in 1890, and in that year an examination and report was made by United States Engineers, under an act of Congress. This information, which was used in connection with the investigation for flood relief at Williamsport, embraced a brief general description of the river and drainage basin.

The flood report refers to the cause of the flood of 1865 and that of 1889. In the former year, the rapid passing away of a large amount of accumulated snow was the chief cause, and in the latter year, the greatest flood known resulted from heavy rainfall. An average depth of 6.6 inches fell in about 34 hours' time, and resulted in a flood height of about 33 feet. Surveys of the affected portion of the city were made and it was found that this flood covered an area of 1,060 acres.

The area of the catchment basin, above Williamsport, is given as 4,500 square miles, and it is said that the storm of 1889 ranged over a considerable portion, beginning at 5 p. m., May 30. At 4 p. m., June 1, the flood attained its maximum height, at a point nearly 30 miles above Williamsport. The maximum flood height at the city was reached about 28 hours after the rainfall ceased in the western region of the basin

and about 4 hours after the cessation in the eastern part. By June 5, the river fell to about the ordinary high water.

The matter of determining means of relief was referred to a board of two engineers, consisting of an officer of the U. S. Engineer Corps and a civilian. This board outlined a general plan of protection embankments to be located directly on, or a short distance back of the natural river bank, and made high enough to meet the requirements of the flood of 1889. The embankments were planned to have a top width of 10 feet with exterior slopes of 1 on 2, paved with stone on the river side.

Concerning the local causes of floods, note was made of certain encroachments and obstructions, and it was considered that a boom dam 10 feet in height, located at the city, increased the flood of 1889 nearly two feet. The report states that the bridge approaches, abutments and piers, together with the heavy riprapping, reduce the cross-section of the river channel an amount, ranging for the four bridges, from 12 to 25 per cent.

The additional recommendations, as summarized, involved the following: The removal of the log boom dam, but if necessary to the lumber interests, the substitution of a movable dam; the enlargement of the river cross-section by removing or replacing bridge obstructions; the taking away of certain islands; the building of a comprehensive drainage system, including an intercepting sewer and a pumping plant, the latter to be in service for relieving the low districts during floods, at which time the mouths of the sewers would be closed by gates. The estimated cost of the whole project, including the dykes, or embankments, necessary sewers and removal of obstructions within the river bed, amounted to about $816,000.

The following may be quoted from the report of the Board of Engineers:—

"As population increases, and the value of property involved in flood injury becomes greater, the necessity will arise for a broad consideration and treatment of flood prevention on the part of the state, or by the joint action of the communities interested. This condition has arisen in Europe, and its corrective has been applied by the extension of state jurisdiction and the establishment of a wise system of conservation over existing forest areas, by the replanting of forests upon otherwise unproductive parts of the watershed, and by the adoption of other means of arresting the rapid delivery of excessive rainfall in the main affluents.

"In view of the recent disastrous floods in many parts of the state, the attention of the public and especially of the Legislature should be earnestly directed to the question of flood prevention, and hearty co-operation should be given to all intelligent efforts to correct the present evil of indiscriminate and injurious forest removal."

A brief discussion on the influences of deforestation and artificial obstructions is included in the general report of the committee, as well as comments upon the use of storage reservoirs and barriers of stone and brush for retarding purposes. The following sections are quoted from the report:

"The destruction of the forests from the mountain crests and slopes of a watershed is undoubtedly the principal cause of the increase of the average magnitude of floods. The evidence collected during the last 25 years establishing this conclusion is well-nigh overwhelming, and it is verified by repeated observations, not only in the mountainous countries of Europe, but also in our own land. By the removal of the forests from the mountain slopes the ground is robbed of its protecting covering of roots, moss, leaves, and porous soil, which forms the forest floor and serves as a natural storage reservoir, holding back the water of rainfall and melting snow, and compelling it to descend slowly to the channels. By the subsequent cultivation of the lands, ditches and drains are made to facilitate the more rapid discharge from the cultivated surfaces, until the rain rushes down the hillsides in destructive torrents, gullying the ground and choking the minor lines of drainage with rocks, sand and gravel, and hurrying into the recipient of the watershed volumes of water which before reached it in a comparatively quiet flow.

"Colonel Torrelli affirms as the result of careful observation that four-fifths of the precipitation in forests is absorbed by the soil or detained by the surface of the ground, to be gradually given up in springs and gentle rills, and only one-fifth of the precipitation is delivered to the rivers rapidly enough to create floods. Upon the same slopes and surfaces denuded of their forests, the proportions are reversed.

"That the destruction of the forests in mountainous watersheds is followed by disastrous floods where previously such floods were unknown is not a matter of theory, opinion, or probability, but is a well established physical fact."

Relative to control by reservoirs and barriers, the following statements are made:

"The method of prevention by storage reservoirs depends for its efficiency upon the ability of the basin to furnish large areas which can be flooded with small injury by dams built across the lower end of the impounding area. To render such dams possible at reasonable cost requires that they should be founded upon rock or other impermeable strata; that the reservoirs at the sites of the dams should reduce from broad areas to narrow gorges; and that the area of the flooded basin should be large enough to keep the height of the dams within safe limits.

"The third method of flood prevention, by transverse barriers carried across the lines of drainage, depends for its efficiency upon the application of constructions at a very large number of points upon the tributaries of the main recipient, whereby their waters are delayed in reaching the main trunk of the basin."

WEST FORK RIVER, W. VA.

Report of Maj. Chas. F. Powell, Corps of Engineers, U. S. Army, on Slackwater Improvement. (1899).

An act of Congress, approved April 29, 1898, authorized a survey of the West Fork River, W. Va., for the purpose of ascertaining the feasibility of the improvement of that stream by locks and dams. The portion of the stream considered was the reach of 31 miles between Clarksburg and the mouth, which is 1.4 miles above the city of Fairmont. The slackwater improvements on the upper Monongahela River, in West Virginia, were then under construction and it was desired to extend this improvement along the West Fork. The survey was assigned to the district officer, Maj. Chas. F. Powell, Corps of Engineers, who placed U. S. Asst. Engineer George M. Lehman in direct charge of the work.

The examination and survey, made in December, 1898, included a study of the geological structure, with special reference to the horizon and proximity of the Pittsburgh coal bed and probable shipments by water. The general commercial needs were given consideration and detailed preliminary estimates as to the cost of the desired improvement were made. It was found that the fluctuations between high and low water were very great. At Clarksburg, in the flood of 1888, the highest stage known reached 25 feet, while at other points below it ranged from about 30 to 38 feet. At the lowest stage, in dry seasons, there were only a few inches on the riffles. The point was therefore brought out, in the report of the Assistant Engineer, that, in case of slackwater improvement, the only way to insure an adequate and well-regulated water supply would be by reservoir storage on the main stream or on a tributary above Clarksburg. This conclusion was concurred with by Major Powell, who also pointed out the low-water troubles on the Monongahela and the benefits that would be derived from storage reservoirs.

It was found that low-water troubles had been met with in the early development of this region and that a project for diverting the water of Buckhannon River, a tributary of the Tygart Valley River, into the West Fork had been proposed. The right to so divert the water had been granted by the State of Virginia, but evidently nothing in the way of actual construction had ever been accomplished.

Major Powell's report, which may be found in the Report of the Chief of Engineers, U. S. Army, for 1900, is in part as follows:

"It is very doubtful if the volume of the river during low stage, which obtains from four to seven months yearly, is sufficient to keep the pools full under more than an inconsiderable number of lockages. Many years ago low timber dams with chutes were built in the river, principally for running flatboats down stream at low stages. The dams not causing enough water for the purpose, Mr. John G. Jackson, the energetic promoter of the enterprise, proposed, under authority granted by the State of Virginia, to divert the Buckhannon River, a tributary of the Tygarts Valley River, above the town of Buckhannon through the divide to Stone Coal Creek, which empties

into the West Fork near Weston, 35 miles upstream from Clarksburg. These localities are shown on an inclosed map entitled, Railroads and Rivers, West Fork River to Ohio River.

"It is found from railroad levels and a Geological Survey topographic map that the diversion would necessitate an artificial channel for the Buckhannon about 9 miles long, besides a three-fourths mile cut at the divide of a maximum depth of 25 feet, or the equivalent of such works. The cost would surely not pay to take only the small low-water flow of the upper Buckhannon; and a storage reservoir scheme there, with feeder to and across the divide, is deemed of doubtful merit.

"The topographic map, however, shows a promising reservoir site on Stone Coal Creek. Assuming secure foundation and a dam 25 feet high, and considering drainage area, minimum rainfall, evaporation, or other probable loss, it seems that an additional volume could be put from a reservoir there directly into the West Fork to supply its probable deficiency for as many lockages as now obtain during low-water season at the middle dam on the Monongahela River. A topographic map north of the Buckhannon sheet, Geological Survey, and west of its proposed St. George sheet, might discover other and better reservoir sites and ones nearer the head of the proposed West Fork slack-water, whose careful investigation would pay before starting on that improvement.

"A special investigation as to reservoirs and their dams in the valleys of both forks of the Monongahela, viz., Tygarts Valley and West Fork rivers, would be judicious. Present low-water supply for the upper locks, and especially for the projected locks on the Monongahela River in West Virginia, will be deficient when they may be freely used, and an increase of low-water flow along other parts of its slack-water system would be highly advantageous. The river is so short that reservoirs near its head would be effective in regulating the flow."

KANSAS CITY, MO. (1904.)

The Kaw River, flowing by a circuitous route near the mouth, enters the Missouri River on the west bank, at Kansas City, Mo., and Kansas City, Kan.

History tells of a great flood occurring in 1844, but a greater one came upon the city in 1903, and a lesser one in 1904 and 1908. The physical damage to the city and immediate vicinity caused by the 1903 flood has been approximately estimated at $25,000,000; the general interference to business, which was enormous, is not included. In 1904 and 1908, the damage is thought to have reached $5,000,000 and $2,000,000, respectively, which, added to the above, would make a total of $32,000,000 within a period of five years. In 1903, railroad traffic was suspended, bridges swept away and communication cut off with the outside world. Street cars were stopped, the cities were deprived of both electric and gas light, and the water works were put out of service. The water was seven feet deep in the Union Station, and about 8,000 freight cars and many passenger cars were submerged.

A report was made by a Board of the U. S. Army Engineers, January, 1904, which submitted results of an investigation on flood conditions and recommendations for remedial measures. This report gives the drainage basin area of the Kaw River as nearly 60,000 square miles, a considerable portion of which was involved by the rainfall which caused the flood of May and June, 1903. The report gives the aggregate population of the cities as 300,000 in 1904, and refers to the great progress of business which has naturally developed on the flat bottom land. This resulted in various encroachments being made along the banks and across the river bed, which even in its original state was too small to properly carry high floods without overflow.

The ground storage had been practically exhausted by a rainfall of 4.5 inches, which extended over a period of 21 days. Immediately after this a nearly continuous rain of 8 inches depth fell in a period of 10 days, which resulted in the record flood of May and June, and a maximum estimated discharge of about 350,000 second-feet. At one place the rainfall amounted to 5.3 inches in 24 hours. The normal rainfall for the month is given as 4.5 inches. A part of the time the water rose about 8 inches per hour, but upon nearing the crest the rate of rise was 1.5 inches per hour. It remained at crest for about 10 hours. From the time the flood reached the banks it took about 26 hours to reach crest stage and about 136 hours to fall back to bank level.

The stream is prairie-like, with arid or semi-arid characteristics, the usual mean

annual discharge having a smaller ratio to the area of the basin than the streams east of the Mississippi, where there is more precipitation. The range between low and high water is greater, for example, the maximum discharge of the Kaw, in the flood of 1903, was about 300 times greater than at the low stage. In humid regions the ratio of 1 to 30 is not often reached. In the process of nature, stream channels usually become formed of sufficient size to carry the ordinary flood volume, but as pointed out in the Kaw report, that stream, in its natural condition, was capable of discharging only about 150,000 second-feet without overflowing. It is said that the channel was smaller than it would be if it were in a region of greater rainfall.

In reference to encroachments and restrictions of the river bed the report states:

"It is understood to be the practice at the yards to dump refuse into the stream, and, this being generally of a character not easily eroded by the current, the banks have gradually advanced until the channel has been greatly reduced. The process has been accelerated by the pressing need of space for the business of the yards and the natural tendency to seek it by encroachment upon the river.

"There are fourteen bridges within this distance and three more a little way above. Nearly all of them are low structures, with from two to four piers in the river. These piers have not been carried down to rock, although the depth is not excessive, but rest upon piles cut off but little, if any, below low water. To protect the foundations from scour, large quantities of stone have been thrown into the river around them, until each pier is surrounded by an island of rock. Between the piers the false-work piles used during construction have in several instances been cut off at or near low water and left in the stream. * * * * *

"Besides the obstructions caused by the bridges, there have been built from time to time stone dikes extending into the stream from both banks to prevent erosion. Other obstructions, the purpose and history of which cannot be determined, exist all along this part of the river. The result of this long-continued process of encroachment is that the channel of the river has been materially diminished in width, its bed has been made so rigid that it will not yield to scour, and it is deprived of this natural relief in time of floods, while its cross section has been diminished by large bridge piers and, in some cases, by the superstructures themselves. It is a conservative estimate that the capacity of the natural channel of the river to carry great floods has been diminished by one-half."

The Board states that it has given consideration to various methods of flood relief, including control by storage reservoirs, which were specifically requested to be reported upon. This part of the work, however, the Board was unable to carry out in full, for the following reason:

"An efficient system of storage reservoirs to control the floods of the Kaw River would have to be coextensive with the watershed of that stream. A proper investigation of the feasibility of such a system would require a survey of nearly 60,000 square miles of territory and the collection of a vast amount of data. The Board has neither the time nor the funds at its disposal for such work, and can therefore only indicate in general terms its views upon the subject."

The report continues as follows:

"While it is not possible to secure precise data as to the discharge of the Kaw River during the late flood, it is estimated that to have held back enough of this discharge to have kept the stream within its banks would have required the storage of not less than 50,000,000,000 cubic feet, or 1,150,000 acre-feet of water. Estimating the unit cost of storage at $10 per acre-foot, which is a low figure, considering the valuable character of the land to be condemned, the total cost of the system would be more than $11,000,000. To this must be added the annual loss to the community from the withdrawal of so much land from productive use. At an average depth of 10 feet, which is about all that could be expected in a region of flat topography like the Kaw watershed, this amount of storage would require an area of about 180 square miles, or 115,200 acres. The most feasible reservoir sites, except those occupied by natural lakes, are where streams widen out in broad areas of flat slope with engorged outlets through which the streams pass and which are suitable for the sites of dams. It is in such situations that large storage can be had with dams of moderate size and cost; but it is also in these situations that the most valuable agricultural lands are found, and their withdrawal from productive use would mean an annual loss to the community of probably $5 per acre, or not less than $576,000. Unless, therefore, the stored water can be utilized for industrial purposes, so as to compensate for the above cost and loss, the creation of a general system of reservoirs would not be justified by the occasional prevention of damages arising from floods.

"In the matter of industrial use there is no question of the great utility of reservoirs in conserving the surplus flow of streams. The practical ease with which power can be transmitted by electricity has given water power an importance which it has never had before and has brought with it a new necessity for the regulation of stream flow in all parts of the country. It is reasonably certain that the storage of water, both through private and governmental agencies, will experience a vast

development in the near future. Unfortunately, industrial use and flood protection conflict with each other to some extent and neither purpose can be fully served except at the expense of the other. For industrial use all surplus water in average years should be stored for use during the season of low water. For flood protection the reservoir should be kept empty until the flood-producing rains come. To combine both purposes effectually the reservoirs would have to be so large that they could store practically all the surplus water in years when great floods occur. Storage enough to take care of a flood like that of 1903 would probably be double that required for industrial use or even for flood control in ordinary years. * * *

"The foregoing are some of the drawbacks that have always proven fatal to the scheme of controlling the floods of large streams by means of reservoirs. Theoretically, the scheme is a perfect one. To hold back the surplus flow of the stream, thereby preventing floods and saving the water for use in time of scarcity, is a plan which has always appealed strongly to the popular mind and still does so, although its weakness, so far as flood protection is concerned, has been demonstrated again and again. It is not a new idea. The Government of France has made exhaustive studies of this question in the valleys of the Rhone and other large streams of that country. Germany has done the same. In every case the result has been that the cost of an effective system of reservoirs is so far out of proportion to the resulting benefits as to be prohibitory. Wherever great reservoirs, or systems of reservoirs, have been built, the primary purpose has been industrial or commercial use, with flood protection a secondary or incidental consideration.

"It is the opinion of the Board, therefore, that the scheme of controlling the great floods of the Kaw River by a system of reservoirs built primarily for that purpose is not feasible."

It was thought that there could be no assurance that a reservoir system could be effectively operated even though the sites were procured at reasonable cost. Attention was therefore confined to the correction of the stream immediately at Kansas City. It was the idea that some security might be had by the building of levees, but the most favorable project was the cutting of a new channel through the city at a cost of $10,500,000. In this project there was included some levee and wall construction. The general plans suggested by the Board of Engineers, together with certain recommendations of a consulting engineer, engaged by a Citizens' Committee on Engineering, are in part as follows:

"This route would require the construction of a new channel for about four and one-half miles, and a levee extending from the bluff on the south side of the valley just above Turner, across the valley and the present channel of the Kaw River near the mouth of the Mattoon Creek, and thence along the right bank of the new channel. The bluffs on the left bank would eliminate the necessity for but one levee. The cross-section of the new channel would have a bottom width of 610 feet, with side slopes of 1½ to 1 on the bluff or left bank, and 3 to 1 on the levee or right bank. This would give a channel width of 812½ feet at an elevation of 45 feet above the bed, and a cross-sectional area of 32,000 square feet, which with an average velocity of 11½ feet per second, would give a high water discharge of 368,069 cubic feet per second. The maximum discharge for the Kaw River during the 1903 flood was less than 350,000 cubic feet per second. * * * In addition, the levee is to be raised 3 feet above the maximum high water line, * * * thus providing an emergency channel capacity for a flood of 35,985 square feet, with a discharge very greatly in excess of the 1903 flood, and in excess of the 1844 flood, or any flood that may be expected in the future. Even this capacity can be temporarily or permanently increased should occasion demand.

"The levee will have a crown width of 100 feet, and side slopes of 3 to 1, which will be revetted where necessary. The average height of the levee will be 20 feet, giving a cross-sectional area of 3,200 square feet, and having a base of 220 feet. This will provide an absolutely safe levee with sufficient crown width for railroad tracks, which can probably be leased for a considerable sum, and to always maintain the levee. * * *

"The shape of the new channel when excavated must be made and formed so that the depth of volume, velocity and quantity of sediment carried by the river will bear the proper relations to each other at different stages of the river, so that the stream will not deposit its sediment in the new channel at some stages and scour out at others. This form will vary for different stretches of the new channel. To maintain this shape or form it will probably be necessary to do considerable revetment work on the bottom and sides of the new channel. At the mouth of the Kaw this relation must be maintained by giving the debouche the proper direction by curving the levees down stream with the Missouri, and extending jetties out into that stream as far as necessary along the north side of the Kaw discharge. * * *

"The rain and surface water will be carried by surface drains to pump wells or reservoirs, and pumped over the levee in time of floods, while in low water periods it will be discharged directly by a culvert through, or a siphon over the levee into the river. During flood it will cost about $140 per day to operate pumping plant. For 30 days this will amount to $4,200, covering the duration of any probable flood. * * *

"The present channel of the Kaw can be filled by the excavated material from the new channel around the bluffs and sold to the railroads and industrial plants. This will greatly accommodate said industries, and transportation interests, and will provide a considerable sum to offset cost of new channel."

This report seems to consider the proposed cut-off channel, which would be further back from the river, against a bluff paralleling the stream, as the most advantageous. The cost for this work would be $16,750,000, but giving credit of $2,500,000 for 600 acres of land reclaimed by filling up the old channel and other parts, the net cost amounts to $14,250,000.

ROCHESTER, N. Y. (1905.)

The City of Rochester, located about seven miles above the mouth of the Genesee River, had frequently received considerable damage by numerous floods, and a joint committee composed of business men and engineers was appointed by the Mayor and the Chamber of Commerce to make investigations and ascertain means for relief. The report, which was made February 1, 1905, contains interesting data bearing upon flood causes and damages throughout a considerable part of the Genesee Valley. This has a drainage area of 2,446 square miles, of which 2,428 square miles are above the city. The stream rises in Potter County, Pennsylvania, near the headwaters of the Allegheny River, and flows northwardly into Lake Ontario.

Mention is made of 25 notable floods, starting with the flood of 1785 and ending with the one of 1902, during which period there appears to be an increasing tendency. The discharge of the larger floods ranges from 20,000 to about 54,000 second-feet, the latter being the maximum discharge reached by the flood of March, 1865. Two floods occurred in 1902, one in March, with a discharge of about 38,000 second-feet and one in July, with a discharge of something over 40,000 second-feet.

The flood of 1865 was attributed to a sudden change in temperature, which caused the rapid melting of a large amount of accumulated snow, and resulted in inundating a large part of the lower sections of the city. The flood of May, 1889, was not so serious in the Genesee Valley as in the Susquehanna and Allegheny. Considering the time of year, the July, 1902, flood was without precedent in the history of this valley. It resulted from heavy rainfall upon previously well saturated ground. It is thought that the Genesee, through a certain combination of elements, may some day have a flood which will discharge at Rochester at least 60,000 second-feet.

The report expresses the opinion that flood troubles are increased on account of the clearing away of the forests and various encroachments and obstructions along the river banks and in the channel. It is recommended that the mill dam, a fixed structure, which crosses the stream at the city, be changed to a movable dam and that certain walls and other structures along the banks be modified.

Relative to storage reservoirs the following quotation is taken from the report:

"*Storage Reservoirs.*—The efficiency of storage reservoirs as mitigators of floods in the Genesee River, has been so thoroughly discussed in the several Genesee Storage reports that very little remains to be said on this point. The great advantage of a storage reservoir in the upper valley is that it reduces floods for the entire river below the proposed dam. The water surface of the proposed reservoir at Portage is so large (12.3 square miles) that a considerable reduction in floods would be obtained by temporary storage on this surface even under the adverse condition of full reservoir at the beginning of a flood. Tables illustrating this proposition are given in the Second and Third reports on Genesee River Storage. The former may be found in the reports of the State Engineer for 1894, and the latter in the report for 1896. * * * The storage reservoir is also of value to the low water power. * * * By increased low water flow of the river, it would also postpone for several years the construction of special methods of sewage disposal."

The idea is advocated of having a complete special system of weather and river observers properly located along the valley to frequently record rainfall, snowfall and temperature, as well as the stage of the water.

NEW YORK STATE WATER SUPPLY COMMISSION.

The New York State Water Supply Commission has been making surveys and investigations during the past few years as to the possibilities of reservoir storage, not only for the retention of the flood waters, but for power development and water supply. Many reservoir sites have been found scattered over the State. One of the principal reservoirs is proposed to be built in the Genesee Valley, tributary to the site of which there is a drainage basin area of 1,024 square miles. The height of the masonry dam would be 152 feet and the length 800 feet. The total capacity of the reservoir will be 19,000,000,000 cubic feet, of which about 30 per cent is to be used for flood control. It is said that the discharge of the river at this site varies from 98 second-feet to 30,000 second-feet. There is a power possibility, immediately below the site, of about 30,000 horse-power.

The Hudson River investigations indicate that to completely control the flood discharges would require storage reservoirs with a combined capacity of 120,000,000,000 cubic feet. In the aggregate about 61,000,000,000 cubic feet of storage capacity have been found. A considerable amount of power has already been developed in this drainage basin and much more is available. The most important single project in this basin would have a capacity of 32,000,000,000 cubic feet, formed by an earthen dam, 95 feet high and 1,200 feet long. It has been estimated that, to the commercial interests of New York State, the annual value of the water power now wasted would amount to about $17,600,000.

THE PASSAIC RIVER. (1906.)

The Passaic River Flood District Commission was created under the authority of an Act of the New Jersey Legislature, approved April, 1904, and April, 1905, respectively. The commission, composed of five members, including engineers, made its report in April, 1906. The report contains investigations as to character of damage and cost of means for flood relief for the lower Passaic valley. Details of cost for plans of relief were prepared by a consulting engineer, assisted by a competent staff.

Twenty-eight destructive floods have occurred since 1877. The damage resulting from the flood of March, 1902, amounted to about $3,000,000, and from the one of October, 1903, reached the large sum of $7,000,000. The report speaks of the undesirability of property subject to flood menace, and the advisability of the erection of protective works which may remove flood dangers and make the value of the affected property as valuable as that of other sections of the valley. The cost of the proposed improvement, by reservoir control, including land, buildings, etc., was estimated at $3,850,000. In this cost is also included canal changes, highways, relocation of two railroads and damages to certain works lying within the site of the proposed reservoir.

An important matter spoken of is the additional need for water supplies for growing municipalities in the valley and it is stated that the only way to satisfy these needs is to provide storage for the waters which now go to waste and at the same time cause so much destruction and inconvenience.

HARTFORD, CONN. (1908.)

In 1908, a committee entitled, "Joint Special Committee on East Side Flood Protection," was formed for the purpose of ascertaining a general plan for relief from the floods of the Connecticut River and for the improvement of sewerage facilities. Efforts to improve the conditions of the city had covered a period of nearly a half century, during which period a number of eminent engineers had reported upon the problem; but none

of these old plans can now be adopted because of the great changes taking place, brought about by municipal progress and the general advance of business.

The most important earlier investigations made were those of 1865, 1866, 1867 and 1896. These reports either favored a system of dykes, raising the streets, or raising the entire flooded area. It is remarked, however, that elevating the entire flooded district is far better in the way of general benefits to the various interests, than the mere system of dykes. In speaking of dykes, one of the early reports practically considers that sheet piling would not prevent percolation but would prevent underground water channels from being formed.

"The prevention of flooding nuisances is most effectively accomplished by artificial means by any one or a combination of the following methods: First, by the construction of huge reservoirs in favorable location upon the upper tributaries, to confine the flood flow until the critical stage has been passed, after which the surplus water, so stored, can be gradually released without injury to persons or property below. The difficulty of carrying out this plan is due to the fact that most large rivers cross several adjoining States, and the coöperation of all interests necessary for the successful accomplishment of this plan cannot easily be obtained. This is especially true of the Hartford problem in its relationship to the Connecticut River. Storage reservoirs to sufficiently confine the flood flow of this stream so as to reduce freshet conditions in Hartford would have to be built in some of the states to the north of Connecticut.

"Secondly, by the removal of obstructions to the normal discharge of rivers. Occasionally temporary ice jams produce serious freshets in the dead of winter, the worst possible period. Other obstructions are caused by the gradual accumulation of debris brought down by streams during flood flow, the debris itself, in many cases, representing an inexcusable waste and financial loss.

"It has been suggested that the widening and deepening of the Connecticut River channel at the Narrows near Middletown would tend to lower the hydraulic grade of the river as far north as Hartford, and thus reduce the freshet trouble to quite an appreciable extent. While I have not made a detailed study of the effect which would be produced here by the execution of such a plan, my impression is that very little, if any, improvement would result. It would no doubt reduce the hydraulic grade for some distance north of Middletown and possibly better the river conditions in the vicinity of the improvement, but I very much doubt if it would be of sufficient help in the solution of the local problem to warrant the city in promoting such a plan for this particular purpose. If successful, it would help only a little in solving the flooding problem, and what we want is not a partial but a permanent abatement of this nuisance.

"Thirdly, by the construction of local flood protection works, to confine the flood flow in artificial channels. Unquestionably the best plan from every point of view is the raising of the entire inundated areas, but where this is impracticable or is extremely expensive, dykes, levees, or retaining walls can be used, and, when properly designed and efficiently constructed, they are remarkably successful. Some one or a combination of these plans seem best adapted for the local situation. If there were larger cities near Hartford, to the north and south, which were similarly afflicted from Connecticut River freshets, it might be possible to secure interstate coöperation looking toward the control of the flood flow upon the upper tributaries of the Connecticut River. But the adjacent towns are not damaged to the extent that Hartford is, principally because of their more favorable topographical conditions, or because their low lying sections along the river front are less densely populated and congested. In view of these conditions, it is clearly evident that Hartford's river flooding problem is a local one, and the benefits to be obtained by preventive measures would also be local. The permanent abatement of the east side flooding nuisance is therefore clearly up to the people of Hartford."

As indicated in the foregoing, the scheme which received attention by the Committee of 1908 was raising, entirely, the low parts of the city to a grade which would bring the ground level nearly one foot above the highest flood on record, which was about 31 feet, occurring in 1854. The danger mark is about 15 feet. The plan included intercepting sewers and controlling gates with pumps of sufficient capacity to handle all sewage and surface water of the affected area during the periods of high water. It was recommended that the interceptor be placed so that the flow is concentrated to one, or perhaps several points, instead of at many ends of old sewers. The pumps would also care for surface water which would collect at times, from heavy local rains, and from seepage through existing embankments, formed by a raised boulevard and railroad, both closely following a portion of the river.

The cost of the improvements was estimated at $1,214,000, about $350,000 of which is for the intercepting sewer. The sewer cost is only roughly estimated, as little

seems to be known regarding the nature of the material to be excavated. No mention is made as to the extent of the overflowed area, or the amount of damage resulting from any of the floods.

The beneficial effect of the improvements upon business is strongly pointed out, as it is considered that flood relief will not only greatly enhance the value of real estate, generally, but rapidly bring about the most modern type of building construction. Reference is made to excessive rainfalls in the valley; in one case, in July, 1.5 inches fell in ten minutes and at another time, in June, 3.5 inches fell in three hours.

ACTIONS OF CHAMBER OF COMMERCE OF PITTSBURGH, PA.

PAPER READ BEFORE THE NATIONAL BOARD OF TRADE, WASHINGTON, D. C., (DECEMBER, 1898).

By George H. Anderson, Secretary, Chamber of Commerce, Pittsburgh, Pa.

Your committee, to whom has been referred the subject of the Storage of Flood Waters on the Higher Tributaries of the Navigable Streams in the Mississippi and Ohio Valleys for Improving Navigation, providing for irrigation, etc., present the following report:

They have given careful consideration to this matter and find it of supreme importance to the welfare and prosperity of the whole nation. The investigation has expanded to an extent that to reach an approximate exhaustive report would occupy more time and space than could be allowed without crowding the consideration of other business properly before your body.

Valuable contributions have been made by those whose ability and experience in the departments of river improvement, irrigation and storage of flood waters are of the highest order; and, as far as possible, their papers have been made an integral part of this report.

Your committee did not rest or form conclusions on reports notably favoring the views received with so much commendation at the last meeting of this Association, having examined with care the opinions of able writers and engineers opposing the system. Deductions have only been arrived at from as full and fair a consideration of the questions from all points of view as was possible under the circumstances.

The work of Charles Ellet, Jr., a distinguished civil engineer, on the Mississippi and Ohio Rivers, written nearly 50 years ago, has proved of the greatest value. His recommendations at that early day did not receive general approval, and in some instances were denounced as chimerical and unpractical.

Today, however, his views in regard to control of flood waters and providing for improved navigation and irrigation by storage reservoirs are receiving practical recognition, and artificial reservoirs to a limited extent have been constructed with important and successful results.

On the Upper Mississippi five reservoirs have been completed by the Government. During the period of lowest water, the reservoirs were opened and the river level was raised 18 inches at St. Paul, nearly 500 miles below the reservoirs, and of course a still higher level was marked on the river near the source of supply. The cost of these reservoirs was less than $2,000,000.

The same amount of money expended on the Missouri, Platte, Arkansas and other streams near the mountain ranges would, from the frequent canon formations, accomplish much greater results, and by a simple process of multiplication, an expenditure of $10,000,000 would yield a return so large, in mitigating destructive floods, in securing abundant water for irrigating arid lands, in improved navigation, in furnishing unlimited power, and in other directions, that it could not be fairly estimated.

The policy and value of internal improvements, especially of waterways, by National Government appropriations is no longer a question. Since such a system has been adopted the commerce, population and wealth of the great Mississippi and Ohio Basins have kept pace in exact proportion to the development and improvement of their navigable rivers.

To retain supremacy of the vast traffic of this region, and keep pace with the advantages of cheap transportation to the Gulf of Mexico, and from thence to the world's markets, the duty of Congress is plain—to continue these improvements to meet the enlarged requirement until these great burden bearers shall accomplish the work intended.

It is evident, from the best authorities on this subject, that a system of improvements, extending from the Rocky Mountains in the west to the Alleghenies in the east, will give cheap and regular transportation on all navigable water-ways in this region, provide a system of irrigation that will bring into fruitfulness an area hitherto barren equal to one-fourth of the United States, furnish an unlimited power, making homes and occupation for millions of people.

The Mississippi Valley, with its unlimited resources of soil, its mineral deposits, its vast manufacturing interests would be comparatively valueless to the traffic of the country without the advantages of its water-way transportation. In it is found the vital artery through which the wealth and prosperity of our country are assured of circulation. It is not too much to ask that the Government shall take charge of and preserve this great boon for the work intended by the Creator.

Annexed to this report, and as part of it, your committee presents a paper from J. P. Frizell, of Boston, distinguished as a civil engineer and author, with as little abbreviation as possible. He is entitled to the thanks of this Association for his masterly and valuable contribution on this subject.

Grouping all these facts together, your committee are free to recommend the passage of the following:

Resolved, that the National Board of Trade, appreciating the value of a system of improvement on the navigable water-ways on the Mississippi and Ohio Basins for irrigating and making productive vast areas of arid lands, for the continued improvement of these rivers for transportation purposes, and diminishing the destructive power of floods, recommend that the Government continue the construction of reservoirs under the direction of competent engineers until a better system shall have been discovered, and further to retain control of all navigable waters and cede no rights to private parties or companies that might interfere with the systematic prosecution of this great work.

All of which is respectfully submitted.

WM. V. EBERSOLE,
G. H. ANDERSON,
E. O. STANARD,
B. A. ECKHART,
J. H. LAFAYE.

The following is extracted from the paper above referred to as contributed by J. P. Frizell, C. E., of Boston, to the Chamber of Commerce of Pittsburgh. This paper was entitled, "Reservoirs for Irrigation, Navigation and Water-power."

* * * No fact of nature is more striking than the variations in the flow of streams.

* * * The wild irregularities in the supply of water naturally lead to the idea of reservoirs to correct these extravagances of nature. To hold the water in seasons of superabundance and release it, according to necessity, in periods of scarcity. To reduce, as far as possible, the flow of streams to uniformity, avoiding, on the one hand, the evil of destructive floods, and on the other, that of protracted scarcity.

Nothing could be more salutary from every point of view than such a result. The problem of river navigation would be immeasurably simplified if a uniform flow of water could be relied on. In every work of river improvement, dams, locks, shore precautions, canals parallel with the streams, groins, wing dams, deepening of channels, or construction of cut-offs, it is the extraordinary flood and the extraordinary droughts which form the perplexing and uncertain element in the engineer's plans.

A river, for instance, flowing in an alluvial bed, constantly tends to come to a stable and permanent regimen. If the velocity at any point is too great, the stream erodes its bed and banks. A bend commences to form, and this action at once quickens the current on the concave shore and deadens it on the convex shore. The former is attacked with increased rigor, deposits occur in the latter, and the bed extends in a wide sweeping curve, till the increased labor involved in the lengthened journey absorbs the superfluous energy of the water. As this channel lengthens, the velocity diminishes, till the current no longer has power to disturb the bed. This is the river's mode of attaining a permanent regimen, viz.: by bringing the resisting power of the bed into equilibrium with the energy of the stream. This is what the river is constantly doing in moderate stages, and this is the condition it would always arrive at if the flow remained uniform.

Reservoirs are built for four leading purposes, which are named in the order of their importance.

1. Municipal water supply.
2. Irrigation.
3. Navigation.
4. Water power.

* * * *

2. *Reservoirs for Irrigation.*

The practice of applying water to land as a supplement to the rainfall, where the latter is deficient in quantity, or occurs at seasons when not required by vegetation, is of very ancient date, as is attested by remains of works for this purpose in Egypt, in India, in China and in South America, works which may be said to antedate authentic history. This is the principal form of irrigation with which we have to do, though not by any means the only purpose of such works.

* * * Irrigation in the sense of a supplement to the rainfall, or a substitute for the same, has in recent years attained considerable development in the western and southeastern portions of the United States. The entire country, west of the 100th meridian of longitude, is a region of deficient rainfall, with the exception of the margin between the Pacific Coast and the coast range of mountains. This comprises a region of some 1,400,000 square miles, being nearly one-half the total surface of the United States. It comprises Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming, and large parts of Oregon, Washington, California, Dakota, Kansas, Nebraska and Texas.

In the most arid section, viz., Nevada, the average rainfall is but little over 6 inches, this being the result of eighteen years observations by the United States Signal Service at thirteen different stations. From this figure, it rises in slow gradations up to 22 inches in Oregon, east of the Cascade Range. West of the range, it rises as high as 75 inches. In large parts of the arid regions the rainfall during the period of vegetable growth is under 3 inches, even when the aggregate for the year reaches 12 inches. This fact shows how little water can be made available for irrigation without the aid of storage reservoirs.

* * * * Within the present decade many comprehensive and well-considered projects of irrigation have been inaugurated, involving large storage reservoirs, canals of many miles in length, tunnels and other works of great magnitude. It needs but little consideration to convince us that irrigation in the arid regions of the United States is destined in future to attain a development beyond our most extravagant conception.

These lands in general have every element of fertility, except water, and need only that to give abundant returns. The present population of the United States is something under 25 to the square mile. We have hitherto called into requisition only the most fertile lands and those workable at the least expense, from which we have been able to produce not only abundant food for our own consumption, but a large surplus for foreign markets. The condition cannot continue indefinitely. At a time, perhaps, too remote to enter into present commercial calculation, but not too remote for the consideration of the reflecting man, this country will have a population of 150 to the square mile, and our wants will have increased faster than our numbers. When that point is reached, we shall not be able to draw supplies of food from other countries, because we must assume that the population of all other countries, so far as they are not already over-peopled, has also increased in like proportion, and that through the influence of civilization, their wants have also increased faster than their numbers. Other countries will have no food supplies to spare. When that time comes, every acre of land that can produce food will be brought into requisition, and all natural agencies that can contribute to the supply of food will be applied to that use. The measurements of the United States Geological Survey show that the annual discharge of all the rivers in this region is no more than adequate to the effective irrigation of the same. It is probable, however, that not more than half the area is susceptible of irrigation by the ordinary means.

Water falling upon the higher ground flows rapidly down the declivities, and gathers into rivulets and streams, or else it sinks into the ground and reappears at lower levels in the form of springs. Most of the streams in this region, after attaining any consider-

able volume, flow in canons or trenches, 300, 500 and even 1,000 feet below the natural level of the country, leaving vast areas inaccessible to water except by pumping.

Remembering these facts, we cannot imagine the stupendous scale on which works of irrigation must be undertaken, when the struggle for existence necessitates the realization of these lands. Dams 300 feet high, canals and pipe lines hundreds of miles in length, pumping plants of 100,000 horse-power, these are the works that may be looked for in the coming century.

The Government owns, or has owned, all the land, and has adopted the policy of selling it in small parcels to actual settlers, to avoid the evils incident to its engrossment and monopolization by large owners. But the land without the water is not land, and not fully susceptible of the ordinary uses of land. Is it not a strange inconsistency to guard the land against monopolization and leave the other co-ordinate and indispensable element of production open to the same? The United States should not part with its control of water in the arid region.

There is probably very little land in the United States not susceptible of improvement in productive capacity by judicious use of water, and works for this purpose will, no doubt, extend and acquire importance as the growth of population necessitates higher demands upon the productive power of the land. This possibility should not be lost sight of in any permanent works for the improvement of rivers.

3. *Reservoirs for Navigation.*

Of reservoirs designed to improve the navigation of rivers, as the word navigation is ordinarily understood, by discharging water into its channels, the most conspicuous example is the system constructed on the headwaters of the Mississippi by the United States Government. This undertaking was seriously proposed in 1867 or thereabouts, as a means of improving the navigable depth on the Upper Mississippi. It was even sustained and commended as tending to restrain the floods on the lower river, but this view was only held by the very thoughtless.

The period of surveys, examination and discussion lasted till 1880, when an appropriation was made for the work of construction. The project originally embraced the Chippewa, St. Croix and Wisconsin Rivers in addition to the Upper Mississippi, but work of construction has been confined to the latter. Work was commenced on the Upper Mississippi in 1882. Up to the present date, there have been completed five reservoirs, as follows:

	Million Cubic Feet
Winnebigoshish, with a capacity of	45,600
Leech Lake, with a capacity of	30,000
Pine River, with a capacity of	7,500
Pokegema, with a capacity of	4,700
Sandy Lake, with a capacity of	3,000

These were all formed by dams at the outlets of natural lakes. Winnebigoshish covers something like 150 square miles. Leech Lake over 200. Winnebigoshish, Leech Lake and Pine River command an area of 2,681 square miles, excluding the water surfaces. On this portion of the drainage ground an anomaly has become apparent. The supply of water has fallen much short of expectation. Measurements of a year's duration in 1881 and 1882 on the main Mississippi, where it has a drainage area, excluding water surfaces, of 6,480 square miles, showed a discharge equal to about 31 per cent of the rainfall. On the Crow Wing where the drainage area is, ex-luding water surface, 3,380 square miles, like measurements give a discharge equal to 40 per cent of the rainfall. On the St. Croix River, with a drainage area, excluding water surface, of 5,780 square miles, like measurements showed a discharge equal to 50 per cent of the rainfall.

Eleven years' observation on the above area of 2,681 square miles show a discharge of less than 20 per cent of the rainfall, which averages in this district 25 inches. The result is that the two great reservoirs have never been filled. Previous to 1897, Winnebigoshish had never been half filled, and the greatest accumulation in Leech Lake was 19,000 millions. In June, 1897, Leach Lake contained 23,000 millions, and some 32,000 millions had been received in Winnebigoshish, but here, the dam being a temporary wooden structure, decay had so far advanced

that it was not deemed prudent to hold the entire influx, and some 3,000 millions had been wasted.

The average annual discharge from reservoirs had been, previous to 1897, some 32,000 millions of cubic feet, equivalent to 4,000 cubic feet per second for 90 days, or 3,000 for 120 days. The outflow of the two great basins passes through Pokegema, which is on the main river, 391 miles above St. Paul. A discharge of 2,000 cubic feet per second from Pokegema raises the water in the vicinity five or six feet. At Aitkin, 165 miles down stream, three feet. At St. Paul, about one foot. The water reaches St. Paul in about eight days from its discharge at Pokegema.

The latest United States engineer reports say that the reservoirs are capable of raising the water at St. Paul 12 to 18 inches for a period of 90 days. According to the report of 1897 of the engineer officer in charge of this work, the total cost of the reservoir system up to June 30, 1896, including surveys, examinations, land drainage and all preliminary work, amounted to $8.78 per million cubic feet of storage capacity, which is low beyond all comparison or example. The facilities for storage offered by these great lakes were entirely exceptional, and such as could not be counted on in any other project.

4. *Reservoirs for Water-Power.*

In consequence of the great fluctuations in the flow of streams, little use is now made of water-power without the aid of steam. On a large stream the power can be used to the extent of the low-water flow without such aid; but if it is desired to develop the power to a larger extent, the only way to avoid vexatious and expensive periods of delay is either to provide storage reservoirs to increase the low-water flow, or a steam engine to supplement it. On streams of drainage area not exceeding 300 to 400 square miles it is customary to make the engine and its appurtenances capable of driving the entire work. The flow of water does not cease entirely on such a stream in the driest time, but it is liable to fall so low that the water wheels cannot use it with economy, and the efficient use of it requires the wheels to stop at times while the water accumulates in the pond till the wheels can work at an economical rate. It often happens also that the work in the course of time increases beyond the maximum capacity of the water power, and the excess has, in that case, to be met wholly by steam.

Without steam or reservoirs it is but a very insignificant fraction of the total flow of any stream that can be used for power by an establishment running without interruption. On the other hand, where reservoirs can be applied to a stream, to an extent which reduces the flow to uniformity or any close approach thereto, all steam-power can be dispensed with, and the quantity of water-power available is greatly increased. The St. Lawrence is an example of a stream reduced nearly to uniformity of flow by reservoirs, and there will probably never be any occasion for the use of steam in connection with the water-power at Niagara Falls, Massena Springs and the Lachine Rapids.

Recent development in electricity, as a medium for the transmission of power between distant points, have, in some measure, recalled the attention of manufacturers to projects for the improvement of water-power, and it is to be expected that enterprises of this character will henceforth receive more consideration. A great obstacle to enterprises of this kind would be removed by a law recognizing the same principle that is embodied in laws for the drainage of fens and marshes and for the construction of dykes, viz., a law permitting a majority of the owners to assess the expense equitably upon all the beneficiaries of the enterprise. To meet the case of a manufacturer who, though in a position to use the water, might have no occasion to use it, the law might take in substance this form: Whenever an association of mill owners on any stream shall, for their common advantage, construct and maintain a reservoir designed to retain the flood waters of the stream, and discharge the same in manner available for water-power, the owner of any dam on the stream below the reservoir who does not pay his just proportion of the cost of the undertaking, shall permit the water contributed by the reservoir, or the equivalent thereof, to run to waste over his dam. This provision would work no hardship to any owner, but would exclude from the benefit of the enterprise those who decline to contribute to the expense, and would make it easy to detect and verify infractions of the law.

The floods of the spring and early summer can be retained and discharged during the

low water of the late summer and autumn to the advantage alike of water-power on the declivities of the stream and navigation on the lower reaches.

The State of New York has recently executed elaborate surveys for reservoirs on the headwaters of the Genesee and Hudson, in the interest both of water-power and navigation. The State has hitherto taken freely from the waters of these rivers for the use of its canals, and so far as the latter river is concerned, the State is, by a curious survival of old Dutch law, not held liable for compensation for such diversion. The equity of the obligation was, however, recognized in a law for the construction of reservoirs, which are expected at the same time to supply the Genesee and Champlain Canals, to largely benefit the navigation of the lower Hudson in addition to great benefits to the water-power interests.

Mr. Anderson.—I would suggest the adoption of the resolution in the report rather than the resolution on the programme, which is simply suggestive and tentative.

The Presiding Officer.—The gentleman from Pittsburgh then offers the resolution at the conclusion of the report read by him, and moves its adoption as a substitute for proposition XLVI on the programme.

Mr. Smalley, of the National Sound Money League.—Gentlemen, I am somewhat familar with the question of irrigation in the West, and do not think it can be combined with the proposition for storage reservoirs to aid navigation. Unquestionably the storage reservoirs at the head of the Mississippi have been of very great service to navigation, but we need no irrigation along the Mississippi. The rainfall is ample. Such rivers as the Platte and the Arkansas are not navigable to any great extent, or at least to any useful extent, and it is the lands along the headwaters of those streams that need irrigation. So that it seems to me that these two questions are quite distinct.

There have been for many years annual irrigation conventions held in the West, their purpose being to try to commit Congress to a series of vast irrigating works, dams and canals on the rivers in the arid region. Nothing has come from those conventions, except, I think, a general public opinion that the question is not one that Congress can wisely take up; that it ought to be left to the States in which these arid lands exist. And following out that line of thought, there has been an Act of Congress, passed three or four years ago, which concedes to each of the States in the arid region 1,500,000 acres of land for use in connection with irrigation. Probably in the course of time all these arid lands will be given up to the States wherein they lie. There is no question but irrigation is valuable to the newer settlers upon arid lands, but irrigation can only be wisely provided by the people where the lands lie and who are to receive the benefits therefrom.

It seems to me that the resolution proposed is too general, and that we ought to have something a little more definite if we are to go into the subject at all. If the Government is to go into the establishment of storage reservoirs at the head of the Ohio, for instance, in aid of navigation, that has nothing to do with irrigation, as you see, any more than at the head of the Mississippi. Then arises the broad question, whether it is worth while to store water at all to fill the rivers? * * *

Mr. Anderson.—Mr. President, I do not propose to consume much time, but I really think our friend who has just taken his seat, does not treat this question in its broadest and best sense. He tells us that the question of the storage of waters at times has no reference to navigation, and instances the Upper Mississippi and Ohio, where it is not needed. They do not need storage of flood waters where the lands are not arid, and the question of the storage of waters for the purposes of navigation is one that has passed almost out of controversy.

We go a step further, however, and observe that the resolution reads very definitely, while it may be somewhat vague in his estimation. It reads in this way:

We recommend to Congress to enact such laws as may place the supervision and direction of all irrigation enterprises in the hands of United States authorities, where such work is undertaken upon waterways affecting interstate navigation.

There seems to be no trouble here about creating reservoirs where we do not need navigation. The committee understands thoroughly that this recommendation is that the works shall be constructed on the streams that are navigable or susceptible of navigation, in order that navigation may be greatly improved, and it reads clearly and distinctly that way:

Upon waterways affecting interstate navigation, involving, as it does, the storage of flood waters on the upper branches of navigable streams.

Whenever the gentleman can bring anything that will answer the purpose better to pro-

vide irrigation for these arid lands out toward the foothills of the Rocky Mountains, forming one-fourth of the area of the United States; when he can bring forward a plan for holding in check the flood waters which have worked such disastrous results in the Mississippi Valley, and provide for establishing these reservoirs for navigation, thus increasing the draft of the river, say 18 inches, and thus subserving the purpose of navigation better, I should like to hear it. That the rivers are to become a back number, that they are to be put on the shelf, is not to be thought of. The traffic on the Ohio and Mississippi today is about 36,000,000 tons. The steamboats on those rivers can carry a world's supply of the heavier articles, and there is no method of transportation under the sun for coal and iron and such heavy articles to tide-water other than on the natural waters which are the handiwork of the Creator. Let it not disturb him that if we build reservoirs there is no land to irrigate, for the lands are there, and they will be irrigated. If, on the other hand, the rivers will be improved whose headwaters are in arid countries, it will serve a double purpose, and will certainly have a tendency to check the floods which have time and again wrought such ruin in the Mississippi Valley. And that is the intent of the committee, that a way shall be pointed out whereby these difficulties in the western country shall be mitigated.

Mr. Leeson, of Boston.—Mr. President, in behalf of the delegation from the Boston Merchants' Association, I wish to express my sense of obligation to the committee which has so thoroughly and carefully considered this subject, and presented for the action of this convention a report, which, if its recommendations can eventually be carried out, will have none but beneficial influence in the direction intended by the framers of the resolution.

Mr. President, there is no subject outside of the preservation of the forests of this continent and the subject dealt with by the resolution offered by Mr. Anderson, of Pittsburgh, which is more vital to the present and future welfare of this nation; and, I repeat, that in behalf of the Boston delegation, I wish to express my deep appreciation of this valuable report; and I trust that, though it may not cover all the technical points which all the authorities might wish, it will have the unanimous vote of this convention.

The Presiding Officer.—Are you ready for the question? If so, the Secretary will read the resolution upon which you are to act.

The Secretary read as follows:

Resolved, That the National Board of Trade, appreciating the value of a system of improvement on the navigable waterways of the Mississippi and Ohio Basins for irrigating and making productive vast areas of arid lands for the continued improvement of these rivers for transportation purposes and diminishing the destructive power of floods, recommends that the Government continues the construction of reservoirs under the direction of competent engineers until a better system shall have been discovered; and further, to retain control of all navigable waters and cede no rights to private parties or companies that might interfere with the systematic prosecution of this great work.

The resolution was adopted.

REPORT OF COMMITTEE OF CHAMBER OF COMMERCE OF PITTSBURGH ON CONFERENCE WITH THE HOUSE COMMITTEE ON AGRICULTURE FOR ACQUIRING NATIONAL FORESTS IN THE SOUTHERN APPALACHIAN AND WHITE MOUNTAINS.

February 4, 1908.

To the President and the Board of Directors of the
Pittsburgh Chamber of Commerce:

Your committee, appointed to appear before the House Committee on Agriculture, of the United States Congress, relative to House Bill No. 10456 of the Sixtieth Congress, First Session, respectfully submit the following report:

This bill is entitled "For Acquiring National Forests in the Southern Appalachian and White Mountains," was introduced by Mr. A. F. Lever, of North Carolina, December 19th, 1907, and referred to the Committee of Agriculture. Briefly, it authorizes the Secretary of Agriculture to acquire, for national forest purposes, lands valuable for their regulation of stream flow in several states in the Southern Appalachian and White Mountain Ranges. Such acquisition, it is expected, will reserve to the conveying owner, the minerals and merchantable timber; with such rules and regulations as to use and obtaining the same, as shall be expressed in the conveyance. It provides further, for the approval of the Legislature in a given state in the acquisition of such lands. It

provides for home-steading of small selected portions which naturally may be included in large tracts, but which are not needed for public purposes and may be available for agricultural purposes without injury to forests. It further provides that 10 per centum of all the money received during each fiscal year, from revenue from any national forest, shall be divided and paid to the state, to be expended for the benefit of the county or counties in which such national forest is situated. It further provides that the Secretary of Agriculture may, for the further protection of the watersheds, in his wisdom, stipulate and agree to administer and protect for a definite number of years, private forest lands in the same way, upon agreement with the owners.

Your committee was fortunate in being able to attend the twenty-seventh annual meeting of the American Forestry Association, held at the New Willard on January 29th, at which time many papers upon the relation between forestry and stream flow and relevant subjects were read. Not to draw comparison, but to mention those particularly applicable to our own interests, we refer to the paper by Mr. W. J. McGee, Secretary of the Inland Water Ways Commission, upon the "Relation of Mountain Forests to Inland Water Navigation." In this he mentioned the valuable resources of our country; namely, soil, and that protection of this soil really commences at home and on the small farming lot, by prevention of small and local erosion, which he pointed out could be thoroughly done by proper forest methods on steep ground and intelligent cultivation in the grounds of lesser slope which are adapted to farming. He brought out the very novel proposition that the muddy turbid water eroded the banks more rapidly than clear water by the grinding action of the grit carried.

Another paper of great importance was that of Mr. Harvey N. Shepherd, of Boston, Massachusetts, on the constitutionality of the bill above referred to. He dwelt upon the fear that some apprehend that the recent decision of the United States Supreme Court, in the Kansas-Colorado case, relative to the use of the Arkansas River, to irrigate the arid lands of the last named state and thus deprive the first named state of water, indicates that the present bill may be unconstitutional. He showed in a clear and logical manner that the recent decision of the Supreme Court was based upon the lack of right of the United States Government to interfere where the end sought was by means of the legislation proposed, and particularly that of depriving one state of water in order to help another; but, that wherever the power existed to do a certain thing, as for instance in this case, the power exists to control and regulate the navigable water of the United States wherever situate, the means sought to produce that end have always been declared by the Supreme Court to be legal, thus, surely, if the United States Government has the right to dredge our streams and provide channels for water ways, it, also, has the right to spend money once for all to prevent the silting up of these streams and provide a more uniform flow of water as a means and aid to navigation.

The same evening, the Steering Committee, under the guidance of Hon. Hoke Smith, Governor of Georgia, and William L. Hall, Assistant Forester of the Department of Agriculture, mapped a plan of campaign for the hearing before the Committee on the following day. It was arranged that your delegation should be heard at this hearing in defense of the bill, because of the interest which Pittsburgh and its vast affairs have in anything which will decrease the damage of floods and increase the availability of the rivers for navigable purposes.

The hearing was conducted in the Ways and Means room of the new House building, from 10 a. m. to 12 m., and from 2 p. m. to 5 p. m., on January 30th.

Among those who spoke, representing various interested sections of the country, there were Governor Hoke Smith, of Georgia, who both opened and closed the discussion; Senator Lodge and Representative Gillette, of Massachusetts; C. J. H. Woodbury, representing the New England Cotton Manufacturing Association; Hon. Gifford Pinchot, of the United States Forestry Service; Governor C. M. Floyd, of New Hampshire; Mr. P. W. Ayers, of the Forestry Service of New Hampshire; Dr. I. C. White, State Geologist of West Virginia; Mr. E. J. Watson, Commissioner of Immigration of South Carolina; Mr. W. S. Lee, Jr., Water Power Engineer of Charlotte, North Carolina; Prof. Geo. F. Swain, representing the American Society of Civil Engineers and the Massachusetts Institute of Technology, and several others of varied interests. Governor Smith spoke first, of inter-state matters; second, of the decrease of the timber supply; third, of the water supply interest; fourth, of the navigation interest. Mr. Pinchot spoke of timber supply and flood damages. Mr. Ayres spoke first, of the climatic effect; second, of the timber supply; third, of the fire damage. Dr. White spoke of the effect on navigation and the danger from forest fires. Prof. Swain spoke of timber supply and the regulation of rivers.

Your committee was heard about 3 o'clock in the afternoon. We first called attention to the

resolution, adopted by this chamber on June 30th, 1907, by virtue of which, the Secretary of Agriculture included in the survey and thus recommended in his report to Congress, dated December 11th, 1907, an area of about 1,100,000 acres on the Monongahela watershed, situate in West Virginia and Maryland. Second, we dwelt upon the important interests about Pittsburgh, and third, as none of this area is situate in the State of Pennsylvania, it is evident that we are not actuated by selfish, at-home motives, and that it is, unquestionably, an interstate affair and one which cannot be regulated by our own State Legislature. Reference was made to the danger and damages caused to the various interests by floods, the accompanying damages by the filling of streams and by erosion, and lastly to the pollution of streams for water supply purposes.

In detail:—The disturbance to navigation by the high floods; the disturbance to railroad interests, most of which are naturally in our valleys and in reach of flood heights; the disturbance to the vast property interests of the manufacturing and business concerns, which are forced to close; the great monetary loss due to the damage to buildings and materials and depreciation of property; the heavy expenses for cleaning up, together with the loss of the wage earners in employment, were all considered; as well as the almost complete stagnation of business due to the electric lighting and street railway operations being endangered by the flooding of the power stations. It was stated that the filling of our harbors and the erosion of the banks and destruction of favorable sites for building operations were serious matters. It was stated that the increased amount of mud and silt in our streams was rendering the problem of filtration of water supplies a more complicated and troublesome one as the years go on.

All of the above was referred to in a concise way and as quickly as possible, on account of the limited time before the committee and the fact that there were many people from afar who had come to be heard. We felt quite favored that an opportunity was given your representatives to be included among those to have a hearing before the committee.

In answer to direct questioning from the Chairman of the committee as to whether floods had not always been prevalent at Pittsburgh, we were pleased to have available, some data, tabulated by your committee, from the Weather Bureau River Records, giving a synopsis of the flood stages of Pittsburgh since 1873, equal to a stage of twenty-two feet or above at Market street. From this we were able to show the tendency by dividing the period of thirty-five years into two equal parts. The number of floods of certain stages are given in the following table:

River Stage (Feet)	Number of Floods 1873-1890 Inc.	1891-1907 Inc.
22	19	26
26	4	11
30	1	4
35	0	1

Thus basing conclusions on the record, it is shown that floods have occurred with greater persistency in recent years, and the same is also noticed both at Wheeling and Parkersburg.

The Chairman of the committee, Mr. C. F. Scott, of Kansas, was affable in his statement of appreciation that so many representatives had come from so many different states. He stated that it was realized that the question is a live and important one and that it would be given thoughtful and earnest consideration.

This committee in closing wish to express their thorough appreciation of the aid which our representatives in Congress have given us, and to the Pittsburgh newspaper representatives in Washington, who were helpful with suggestions.

While the subject does not apparently have the same vital effect to us, so far as the present allotment on a single watershed tributary to the Monongahela River, that it seems to have for some other places which are directly subservient for their entire livelihood upon the rivers which flow by their doors, and while it is also true that the Monongahela watershed still has a somewhat larger amount of timber than many of the areas in mind by the originators of the bill; it is true that unless we are alive to this question and take time by the forelock and be aroused, it may at any time be found too late and that the opportunity has slipped by and we may awake to find our streams in much worse condition than at present, with floods higher and more frequent, with the erosion much greater, and with the dry weather flow much lessened.

Now that the general government has been willing to include about 1,000,000 acres for the first allotment of this great project, the matter assumes immediate importance and should command the interest and support of the members of this Chamber and all of the citizens of this community, who have its welfare at heart.

Your committee, therefore, recommends that this Chamber adopt proper resolutions to be sent, and urge each one of our representatives in Congress, that having due regard to the continuance and prompt completion of the necessary work already under way for the improvement of our rivers, but, also, mindful of the enormous losses yearly entailed by destructive floods and low water, and that these will increase with future needs and development, that such action as is feasible be taken to promote the passage of this bill at the earliest possible date.

(Signed) MORRIS KNOWLES,
GEORGE M. LEHMAN,
Committee.

CORRESPONDENCE PRECEDING APPOINTMENT OF FLOOD COMMITTEE.

(Referred to in "History and Objects of Commission.")

"Mr. Logan McKee, "Pittsburgh, Pa., Feb. 15, 1908.
Secretary Chamber of Commerce,
Pittsburgh, Pa.

Dear Sir:—

"As reliable information has never been obtained, concerning flood losses, or character of same, incurred by the various interests in and about the City of Pittsburgh, it seems to me that the Chamber of Commerce should take this question up at once. The city, so far as I am aware, does not know how it stands in this matter and an investigation may prove of great value, in many respects.

"Information can only be secured by a fairly thorough canvass, or going over, of the district. A reasonably accurate estimate may be made from information received by letter from those affected along the rivers. I see no reason why any should refuse the information.

"The letter of request sent out by the Chamber would be accompanied by a blank form, for return, setting forth in tabulated way the information desired. If details are not known by those receiving the letters, or there should be no desire to give them, the data can be grouped in part or as a whole. The floods of March, 1907, and February, 1908, should be treated separately.

"At this moment I have no fully formed plan, but think that letters should be addressed to the following:

"Manufacturing plants; mercantile houses; office buildings; theatres; hotels; railroads; U. S. Engineer office; river interests; City of Pittsburgh; water supply companies, etc. Information requested should be something like the following:

"Damage to buildings; damage to equipment; damage to land; expense of cleaning up; loss to employer due to shut-down; loss to employees due to shut-down; damage to mercantile goods; damage to roads, bridges; damage to river craft and land transportation companies.

"In connection with this work, it would be well to have the city obtain, through its engineering force, information regarding the boundary line of the flooded areas. This can be gotten at little expense with several men by simply sketching upon city maps the flood line as the areas are examined. Any assistance that I can render will be gladly given, in arranging the estimates which would be made from the answers received.

"I will say something to Mr. English about this matter.

"Yours respectfully,
GEORGE M. LEHMAN."

"H. D. W. English, President "Pittsburgh, Pa., Feb. 18, 1908.
Chamber of Commerce,
Pittsburgh, Pa.

Dear Sir:—

"Permit me to kindly call your attention and that of the Chamber of Commerce most earnestly to the fact that we are face to face with three propositions most essential for the material interest, health and attractiveness of our City, viz:—

1. That of sewage disposal.
2. The walling out of floods from our rivers.
3. The freeing of the bridges across the Allegheny River to the North Side.

"I speak of these questions now because they are not only imminent, but the most portentous and far reaching of any of the questions that now or even hereafter will face our City. I also speak of them now because I am afraid that in our planning for a new City Hall, and other contemplated improvements of the kind, we will lose sight of these most important and essential things, and which we must do, no difference from what standpoint we value them.

"If we go ahead and provide enough money to do the minor improvements, which are now talked of, and all of which may be desirable and may have to come in time, will we not have so exhausted the ability of our City to raise money, and thereby be compelled to put off these essential things until our City has further suffered great loss and gotten into trouble with the State over the sewage disposal? Hence, had we best not first do these essential and compulsory things?

"The very full report that was submitted by the Committee appointed by the Chamber of Commerce on the question of sewage disposal, of which perhaps every member of the Chamber received a copy, showed conclusively not only the propriety and wisdom of providing, without delay, for proper sewage disposal, but, also, that the City of Pittsburgh had no choice in the matter. For, the State has made it obligatory on the municipalities throughout the State to provide means for sewage disposal, and it is clearly evident that the authorities will and must have the municipalities comply therewith. The time limit in which the City of Philadelphia must so provide is now less than five years. Besides, our City must set an example so that she can, in turn, demand of the State to insist upon the boroughs or municipalities up the rivers providing for sewage disposal, in order that the streams from which we take and must take our water supply will not be polluted.

"If the pollution of our rivers and streams emptying therein is not stopped by the Boroughs and Municipalities, we will soon have reached a point where our present filtration plant will not give us a supply of water which can be safely used. To provide for a proper system of sewage disposal will probably cost as much as $6,000,000, and possibly upwards, and to arrange to do the work soon will save the City a large amount of money; for as time goes on the cost of the land necessary for such a plant will have increased.

"It needs no argument to show that the floods which take place in our rivers from time to time, not only destroy a vast amount of property, but also cause great loss by throwing men out of employment, as well as dire distress and great suffering among a certain class of our population who must live in the flooded districts. If the damage which has been caused from our late flood could be compiled, and put together, it possibly would be of a sum sufficient to pay the expense of walling out the flood, or at least meeting the interest for many years on the expense thereof.

"Besides, it is proper here to remark that we are facing the question of arranging our wharfs so that the freight, etc., can be loaded and unloaded without being compelled to haul up and down the steep, rough and dangerous wharfs and this together with the question of sewage disposal all well fits in with the question of walling out the floods. We are all proud of our City's great commercial importance, but what would add so much thereto or create here the greatest commercial distributing and jobbing center in the whole country, so much as to have it experienced at home and known abroad, that the streams from which we take our water supply are protected by sewage disposal, and that our City is free from inundations, and that there was no barrier piled up in the way of toll bridges. If these things are accomplished, and they can be if we only so determine and go to work while we have the means at our disposal, it would make our City take a bound forward and place her pre-eminently among other of the great Cities of our land.

"Permit me to dwell on the following points; namely, it is essential to convince those at home, and consequently those abroad, that this City is a healthy place to live because we have a pure water supply, and consequently comparatively free from epidemics, and that our valuable buildings, and contents, and machinery thereof in the wholesale and retail districts, as well as our manufacturing plants, are free from damage by floods, and that our traffic is not impeded by toll gates. While nature and circumstances, and peculiar conditions have done much for our City, and notwithstanding our citizens have been exceedingly prosperous, yet we should stop and ask the question, Can our City hold this great commercial supremacy, or our citizens continue to be eminently prosperous, unless we now do something for ourselves?

"The time has passed away when we would be permitted, and the circumstances that would tolerate the condition whereby our streams and rivers may be polluted by sewage discharge, or that our City annually or oftener shall be subject to inundations with the great loss attended

thereon, or that we shall be charged a toll for passing from one part of our City to another. Therefore, the duty and responsibility clearly rests on the City and those interested in her welfare to see that we do not longer procrastinate to do these things that so loudly cry out and condemn us in the eyes of our neighboring cities, or those who would, because of other conditions, be glad to locate with us and further add to our prosperity and material worth.

"I, therefore, beg to suggest that the Chamber by unanimous consent authorize you to appoint a special committee to at once wait upon the City authorities and Councils and ask the early and serious consideration of these subjects:

"First: That proper steps be taken towards freeing the bridges crossing the Allegheny River without delay.

"Second: That a commission of seven (7) be appointed to suggest the manner in which the floods can be best walled out, and at the same time how our wharfs can be made of some commercial importance, and how the sewers necessary for the sewage disposal, and, at the same time, the sewage disposal plant, can best be provided for, with the probable cost of doing the work, and that this commission consist of two engineers of known ability, who shall be under pay, and an attorney of high standing who shall be reasonably compensated for his services, and four laymen to be selected to represent the different interests of the City, and who shall serve without pay.

"I suggest a special committee, because I know the standing committees, especially that of Municipal Affairs, to which this communication would logically perhaps be referred, are already overburdened with matters which require perhaps more time than the members of the committee are able to give.

"Most respectfully submitted,

A. J. Kelly, Jr."

CONFERENCE HELD BY PRESIDENT TAFT WITH THE FLOOD COMMISSION OF PITTSBURGH.

White House, Washington, D. C., Nov. 28, 1911.

At the request of the Flood Commission, President Taft held a conference at the White House, at which he was urged to incorporate in a message to Congress a recommendation for the flood relief measures proposed by the Flood Commission.

Thirty members of the Flood Commission were present at the conference, and in addition to them, the following officials took part: U. S. Senator George T. Oliver; Congressmen Burke and Dalzell; Mayor William A. Magee, of Pittsburgh; Assistant City Solicitor John B. Eichenauer; County Controller R. J. Cunningham; County Commissioner I. K. Campbell; Assistant County Solicitor Edward B. Vaill, and John Birkinbine, Chairman of the Water Supply Commission of Pennsylvania. Secretary of State Philander C. Knox, Secretary of War Henry L. Stimson, and Secretary of the Interior Walter L. Fisher were present during the conference and took part in the discussion.

Mayor Magee made the first address to the President, in which he outlined the history and objects of the Flood Commission. He was followed by George H. Maxwell, Executive Director of the Flood Commission, who made a plea for the restoration of the money that had lapsed from the Appalachian fund. The following paper was left with the President:

"That there be re-appropriated the unexpended $1,000,000 appropriated for the fiscal year 1910 and the unexpended balance of the $2,000,000 appropriated for the fiscal year 1911, representing a total of approximately $2,700,000 in accordance with an Act approved March 1, 1911, known as the Weeks' Appalachian National Forest Act.

"And that in the expenditure of these and all other sums appropriated and to be appropriated for the purposes of said Act the National Forest Reservation Commission carefully consider the recommendations based upon the surveys and investigations of the Flood Commission of Pittsburgh concerning the acquisition of certain lands for reservoir purposes in aid of the navigability of the Ohio River.

"And that the attention of Congress be directed to the desirability of enacting such legislation as shall be necessary to utilize the said lands so acquired by the construction of proper reservoirs thereon."

President Taft showed a keen interest and stated that he would recommend the restoration of the Appalachian money.

THE NEWLANDS BILL.

In the Senate of the United States, March 1, 1911.

Mr. Newlands introduced the following bill; which was read twice and referred to the Committee on Commerce.

A BILL to create a Board of River Regulation and to provide a fund, for the regulation and control of the flow of navigable rivers in aid of interstate commerce, and as a means to that end to provide for flood prevention and protection and for the beneficial use of flood waters and for water storage and for the protection of watersheds from denudation and erosion and from forest fires and for the coöperation of Government services and bureaus with each other and with States, municipalities, and other local agencies.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the sum af $50,000,000 annually for each of the 10 years following the first day of July, nineteen hundred and eleven is hereby reserved, set aside, and appropriated, and made available until expended, out of any moneys not otherwise appropriated, as a special fund in the Treasury, to be known as the "River Regulation Fund," to be used for the regulation of interstate commerce and in aid thereof for examinations and surveys and for the construction of engineering and other works and projects for the regulation and control of the flow of navigable rivers and their tributaries and source streams, and for the standardization of such flow, and for flood prevention and protection, by the establishment, construction, and maintenance of natural and artificial reservoirs for water storage and control, and by the protection of watersheds from denudation and erosion and from forest fires, and by the maintenance and extension of woodland and other protective cover thereon, and by the reclamation of swamp and overflow lands, and by the building of drainage and irrigation works, and by doing all things necessary to provide for any and all beneficial uses of water that will contribute to its conservation or storage in the ground or in surface reservoirs as an aid to the regulation or control of the flow of rivers, and by acquiring, holding, using, and transferring lands and any other property that may be needed for the aforesaid purposes, and by doing such other things as may be specified in this Act or necessary to the accomplishment of the purposes thereof, and by securing the coöperation therein of States, municipalities, and other local agencies, as hereinafter set forth, and for the payment of all expenditures provided for in this Act; the purpose of this Act being river regulation and the control of the volume of water forming the stage of the river from its sources, so as to standardize the river flow, as contradistinguished from and supplemental to channel improvement as heretofore undertaken and provided for under the various Acts commonly known as the river and harbor Acts.

CREATION AND MEMBERSHIP OF BOARD OF RIVER REGULATION.

Sec. 2. That a board is hereby created, to be known as the "Board of River Regulation," consisting of the Chief of Engineers of the United States Army, the Director of the United States Geological Survey, the Forester of the Department of Agriculture, the Director of the Reclamation Service, the Chief of the Bureau of Plant Industry of the Department of Agriculture, the Secretary of the Smithsonian Institution, one civil engineer, one sanitary engineer, and one hydroelectric engineer. The last three shall be appointed by the President and hold office at his pleasure, and they shall each receive an annual compensation of $7,500, payable out of the appropriation hereinafter apportioned to the Smithsonian Institution. The members of said board, with the exception of the three members appointed by the President, shall serve as such only during their incumbency in their respective and official positions, and any vacancy on the board shall be filled in the same manner as the original appointment. A chairman and a secretary of the board shall be elected annually by the board from its members.

All formal action taken and all expenditures made or authorized by the board shall be reported to the President of the United States, and shall be by him transmitted to Congress annually, or at such more frequent times as may appear to him desirable, or at such times as Congress may require.

COOPERATION WITH STATES, MUNICIPALITIES, AND OTHER AGENCIES.

Sec. 3. That the board shall, in all cases where possible and practicable, encourage, promote, and endeavor to secure the coöperation of States, municipalities, public and quasi-public corporations, towns, counties, districts, communities, persons, and associations in the carrying out of the purposes and objects of this Act, and in making the investigations and doing all coördinative and constructive work provided for herein; and it shall in each case endeavor to secure the financial coöperation of States and of such local authorities, agencies, and organizations to an extent at least equal in amount to the sum expended by the United States; and it shall negotiate and perfect arrangements and plans for the apportionment of work, cost, and benefits, according to the jurisdiction, powers, rights, and benefits of each, respectively, and with a view to assigning to the United States such portion of such development, promotion, regulation, and control as can be properly undertaken by the United States by virtue of its power to regulate interstate and foreign commerce and by reason of its proprietary interest in the public domain, and to the States, municipalities, communities, corporations, and individuals such portion as properly belongs to their jurisdiction, rights, and interests, and with a view to properly apportioning costs and benefits, and with a view to so uniting the plans and works of the United States within its jurisdiction, and of the States and municipalities, respectively, within their jurisdictions, and of corporations, communities, and individuals within their respective powers and rights, as to secure the highest development and utilization of the waterways and water resources of the United States.

The board may receive and use any funds or property donated or subscribed to it or in any way provided for coöperative work, but no moneys shall be expended under any arrangement for coöperation until the funds to be provided by all parties to such arrangement shall have been made available for disbursement.

ENCOURAGEMENT OF INDEPENDENT INITIATIVE AND CONSTRUCTION.

Sec. 4. That all things done under this Act shall be done with a view not only to constructive coöperation, as herein provided, but also with the definite and specific object of enlarging the field of accomplishment contemplated by the Act through promoting and encouraging independent initiative and construction by States, municipalities, districts, and other local agencies and organizations, and creating object lessons and building models and making demonstrations that will have that effect and influence, and induce such supplemental and independent action and construction.

CONFERENCE AND COOPERATION OF BUREAUS AND STATES.

Sec. 5. That it shall be the duty of said board to coördinate and bring into conference and coöperation the various scientific and constructive bureaus of the United States with each other and with the representatives of States, municipalities, public and quasi-public corporations, towns, counties, districts, communities, and associations in the carrying out and accomplishment of all the provisions, purposes, and objects of this Act.

The board shall have authority to call upon and to bring into coöperation any other Federal department or bureau whose investigations or assistance may be found necessary to the carrying out of the provisions of this Act, and the board is hereby authorized to defray the expenses of such investigations or assistance through a transfer of so much of its appropriation as may be necessary to the Federal department or bureau thus brought into coöperation.

CORRELATION, COORDINATION, AND ADMINISTRATIVE ECONOMY.

Sec. 6. That the board shall harmonize and unify and bring into correlation and coördination the investigations made, and information, data, and facts collected and obtained by the various bureaus or offices of the Government relating to or connected with the matters and subjects referred to and the questions involved in this Act, and to print, publish, and disseminate the same, and it shall exercise such general supervision as may be necessary to provide against duplication or unnecessary, inadequate, unrelated, or incomplete work in connection therewith, and shall make such recommendations to the President as it may deem advisable at any time for the accomplishment of that end or in the interest of harmonious coöperation, efficiency, and economy in carrying out the purposes of this Act. The special function of the board at all times shall be to promote the adoption of the best and most approved methods and systems of investigation, administration, construction, and operation, in carrying out such specific improvements, works, and projects as are authorized by this Act, or which may be from time to time authorized by Congress, if within the scope of the work of the said board as herein set forth; and it shall further be the special function of the board to effect the largest possible saving as the result of the unification, correlation, and coördination of the work of the various bureaus in the investigations and administrative and constructive work provided for in this Act in accordance with existing law or with such provisions as Congress shall from time to time impose.

REPORTS, PLANS, AND ESTIMATES BY THE BOARD.

Sec. 7. That the functions of the board shall be to obtain full information through its members concerning all proposed expenditures provided for within the scope of this Act. Each bureau chief member shall report to the board the work proposed by the bureau or organization which he represents, and shall present full plans and estimates covering such proposed construction or action. The findings and conclusions of the board and plans adopted by it for construction and action shall be binding upon the members thereof in so far as may be consistent with existing laws.

REFERENCES TO AND INSTRUCTIONS FROM THE PRESIDENT.

Sec. 8. That all matters involving apparent conflict with departmental authority, jurisdiction, or procedure, or as to which the board may desire suggestions or advice, shall be laid before the President, who may thereupon call into conference the Secretaries of the departments represented on said board, and thereafter suitable instructions shall be issued by him to heads of departments with a view to securing unity of action along the lines approved by the President.

EXECUTION OF PLANS AND WORK BY THE SEVERAL BUREAUS.

Sec. 9. That in the execution of all plans and duties intrusted or delegated to the several bureaus the respective chiefs thereof, acting under departmental regulations and procedure, shall execute the work according to the methods prescribed by law, the functions of the board being those of a consulting and advisory body with power to make recommendations to the President, and through the President to the heads of departments, with a view to effective coördination and coöperation as to all things proposed by this Act, and to carry out such work as Congress shall from time to time prescribe or has prescribed in this Act.

COMPREHENSIVE PLANS FOR RIVER REGULATION.

Sec. 10. That the board shall develop, formulate, prepare, consider, and determine upon comprehensive plans for the conservation, use, and development of the water and forest resources

of the United States in such manner as will best regulate the flow of source streams and navigable rivers, and embracing, with that object, flood protection, drainage, and the reclamation of swamp and overflow lands; water storage in natural and artificial reservoirs; the beneficial use of waters for irrigation and for all domestic, municipal, and industrial purposes; the maintenance and development of underground water supplies and the storage of waters in the ground and in irrigated lands and underground reservoirs; the enlargement of the areas and raising of the levels of the ground waters; the construction of flood-water canals, by-passes, and restraining dams; the control and regulation of drainage and the replenishment of streams by return seepage; the perpetuation of forests and maintenance of woodland cover as sources of stream flow; the prevention of denudation and erosion; the protection of river channels from eroded soil materials; the clarification of streams; the utilization of water power; the prevention of the pollution of streams and rivers; the sanitary disposal of sewage and purification of water supplies; the best distribution of forests, woodlands, and other growth, and of cultivated and irrigated areas in their relation to river flow; the protection of forested and woodland areas from destruction by fire or insects; the reforestation of denuded areas; the planting of forests and establishment of forest plantations; the preservation and planting of woodlands and any other growth and protective cover on watersheds; the increase and development of the porosity and absorbent qualities and storage capacity of the soil upon which rain or snow may fall; the making and furnishing of plans for flood-water storage and other works for irrigation and power for farms, towns, and villages; the acquisition, subdivision, and settlement in small, intensively cultivated farms of lands for water storage by irrigation; the building of the irrigation systems for such lands, including reservoirs, dams, canals, ditches, and all necessary works; the protection of farms, villages, towns, and municipalities from damage by freshets and overflow; and the impounding of flood waters in artificial lakes and storage reservoirs to prevent floods and overflows, erosion of river banks, and breaks in levees, and to regulate the flow of streams and reënforce such flow during drought and low-water periods, the ultimate object of all such work being to regulate and, so far as possible, standardize the flow of navigable rivers and source streams, and in the accomplishment of that object to induce and secure the coöperation of States, municipalities, districts, counties, towns, and other local agencies and organizations.

SMITHSONIAN INSTITUTION.

Sec. 11. That it shall be the duty of the Secretary of the Smithsonian Institution to give especial attention to the acquisition from foreign countries and from all sources of all obtainable knowledge concerning the problems involved in the work of the board and to diffuse and disseminate the same, and to establish and maintain a Museum of Conservation in which such knowledge shall be placed before the people, with object lessons illustrating the disastrous consequences that have resulted from the failure of such conservation and particularly the failure to conserve the forest and water resources in other countries of the world, and to utilize the resources of the institution under his charge, which may be available for that purpose, to aid in the education of the public in the elements of knowledge which lead to the successful regulation of water and of the flow of rivers and the use of water in connection with agriculture and the intensive cultivation of land, and in connection with all other industries.

BUREAU OF PLANT INDUSTRY.

Sec. 12. That it shall be the duty of the Chief of the Bureau of Plant Industry to collate and bring together for the information of the board the results of all investigations with reference to soil and the production of crops through the use of water as a fertilizer and stimulant to plant growth, and of the relation of water in excess or deficiency to successful crop production. He shall recommend for the consideration of the board such further investigations as may properly be conducted in connection with the purposes for which the board is created and which shall lead to the largest and most valuable results being obtained through the use of water in connection with successful plant growth and increased crop production, and the establishment of a national system for the information of the people in the intensive cultivation of small tracts of land, with a view to increasing food production and thereby reducing the cost of living and encouraging suburban and rural settlement and homemaking, and the beneficial use of water in connection therewith.

FOREST SERVICE.

Sec. 13. That it shall be the duty of the Forester of the Department of Agriculture to present to the board all essential facts bearing upon the relation of forests to the various problems under consideration and the value and importance of forests and woodland and other growth upon the headwaters of streams and their proper control and extension and protection from fire, as regulators of stream flow; also such facts as may be essential to the proper enlargement of forested areas for the protection of watersheds and the maintenance of the flow of rivers during the low-water season and the prevention of denudation and erosion, with consequent silting up of channels, and to prepare and present to the board comprehensive plans for the protection of the forests from fire and other destructive agencies.

GEOLOGICAL SURVEY.

Sec. 14 That it shall be the duty of the Director of the Geological Survey to recommend to the board appropriate surveys and examinations, and upon proper approval cause to be executed topographic surveys of each drainage basin, these being planned with reference to the work con-

templated by the board and the immediate demands and needs of the board. Such surveys shall include and show in addition to the topography the character of all lands embraced therein and it shall be his duty to classify the same and designate the best use to which said lands may be devoted in carrying out the provisions of this Act. The topographic maps shall be of such scale as will bring out the existence of feasible storage or reservoir sites, and he shall make such additional surveys of specific localities as may be required by the constructing engineers, and in such surveys he shall establish monuments based on geodetic horizontal and vertical control. And the surveys shall be of such nature as to provide adequate bases for geologic investigation and engineering works. He shall also cause measurements to be made of the flow of streams at such places as may be designated by the board as yielding results of largest importance in the discussion of the problems in hand and the execution of proposed engineering works, and shall carry on such studies in river pollution and purification, in water-power possibilities, and other stream investigations as the board may designate. It shall be his further duty to examine all forested lands or lands intended to be afforested or reforested which it is proposed to purchase under this Act, and to report upon whether the control and use of such lands will influence the preservation of water supplies or stream flow or tend to regulate the flow of navigable rivers on whose watersheds they are located.

RECLAMATION SERVICE.

Sec. 15. That it shall be the duty of the Director of the Reclamation Service to bring before the board the results attained in the construction of works of irrigation and reclamation throughout the arid and semiarid regions of the United States and the application of the experience thus obtained to the conditions existing in the more humid sections of the United States. He shall extend the surveys and investigations and construction of irrigation works such as are authorized in the Act of June seventeenth, nineteen hundred and two, known as the National Irrigation Act, throughout the United States and including reclamation of land by drainage as well as by irrigation: *Provided, however,* That no part of the fund created by the Act of June seventeenth, nineteen hundred and two, shall be expended for this purpose. Such further investigations and construction and operations in States other than those covered by the original Act above referred to shall be subject to the terms, provisions, and requirements of the said National Irrigation Act that may be applicable thereto, but shall be at the expense of the River Regulation Fund created by this Act, and expenditures from said last-mentioned fund may be made in any State or Territory. He shall construct, operate, and maintain, until otherwise provided by law, such irrigation works and systems as the board may determine are needed for the regulation of the streams and rivers and the improvement of agricultural conditions, or for the proper control, disposition, and utilization of sewage or other waste waters which, without such regulation, would pollute the streams or injuriously affect the health or prosperity of the community. He shall also present to the board proposed plans for coöperation with irrigation or drainage projects or enterprises constructed, initiated, or contemplated by States, districts, municipalities, corporations, associations, or individuals, and shall negotiate agreements for coordinating and making more useful works already in existence or proposed through their incorporation into more effective systems.

CORPS OF ENGINEERS, UNITED STATES ARMY.

Sec. 16. That the Chief of Engineers of the United States Army shall present to the board all proposed plans for levees, dikes, revetments, bank-protective and drainage works, and other works for river improvement which are proposed to be built under this Act, and also all plans for the construction of reservoirs for the storage of flood waters, for flood prevention and river control which may be proposed to be built under this Act, or for which examinations and surveys have been made by or with the cooperation of States, municipalities, or districts, and which it is sought to have constructed under this Act, together with such facts and data as may be required for the construction of such works, or any of them, for the regulation of the flow of rivers. He shall also construct, operate, and maintain such levees, flood protection and drainage works and reservoirs as are built in accordance with this Act for the storage of water to control and regulate the flow of rivers, and to reenforce such flow in seasons of low water and to prevent floods and protect lands and communities from overflow: *Provided, however,* That the provisions of this section shall be so administered as in no way to supersede or conflict with any specific provisions which Congress shall from time to time make by way of appropriations other than such as are made by this Act for work and improvements to be performed or maintained by the Corps of Engineers, United States Army, but that all work prescribed under this section shall be supplemental to and coordinated with the work as specifically prescribed by Congress in other Acts.

ENGINEER APPOINTEES OF THE PRESIDENT.

Sec. 17. That it shall be the duty of the three engineers appointed by the President under the direction of the board to consider and present comprehensive plans for the best utilization of the water resources of the United States in connection with river regulation along their respective lines, namely: Questions relating to general construction work; to water pollution, water purification, health, and sanitation; and to water-power problems; and to adjust all the plans contemplated for the projects constructed under this Act to the central controlling purpose of regulating and standardizing the flow of the rivers of the United States, and to further give

expert advice to the board in its consideration of details, problems, and projects; and it shall be their special duty to constantly promote and stimulate harmonious and effective cooperation between the Nation and States, municipalities, and other local agencies in working out constructive plans under this Act. And it shall further be their special duty to carefully scrutinize and study the plans presented to the board for consideration, with the view of promoting the fullest possible measure of efficiency and economy in administration and construction, and avoiding all duplication in the work of the respective bureaus.

EQUITABLE APPORTIONMENT AMONG WATERWAY SYSTEMS.

Sec. 18. That in carrying out the provisions of this Act regard must be had, as far as practicable, to the equitable apportionment and contemporaneous execution of the works and projects contemplated under this Act among the several waterway systems of the United States.

REPLENISHMENT OF RIVER REGULATION FUND BY BOND ISSUE.

Sec. 19. That the President is authorized, whenever the current revenues are insufficient to provide the fifty million dollars appropriated for the River Regulation Fund, to make up the deficiency in such fund by the issue and sale of United States bonds, bearing interest at a rate not exceeding three per centum per annum, payable semiannually, and running for a period not exceeding thirty years.

APPROPRIATIONS AND APPORTIONMENT.

Sec. 20. That the moneys hereby annually appropriated in section one of this Act shall be apportioned and expended by the services and bureaus herein named in carrying out the purposes and provisions of this Act and under the direction of the heads of the respective departments and in accordance with existing laws and regulations or such modifications thereof as may be made from time to time in accordance with the general system proposed by the board and approved by the President of the United States, in the following sums annually, which shall be available until expended:

For the Smithsonian Institution, for obtaining information and material relating to the subjects covered by this Act in the United States and foreign countries, and publishing and distributing the same to the people of the United States, and for the establishment and maintenance of a Museum of Conservation of Forest and Water Resources, and for any other purposes mentioned or referred to in section eleven of this Act, one million dollars.

For the Bureau of Plant Industry, for the establishment and maintenance of garden schools and demonstration garden farms, and instruction in irrigation in model rural industrial communities, and for investigations and instruction with reference to terracing and methods of cultivation on hillside slopes adapted to preventing erosion, and with reference to the use of water as a fertilizer and stimulant to plant growth, and for the acquisition of lands that may be required for such purposes, and for any other purposes mentioned or referred to in section twelve of this Act, two million dollars.

For the Geological Survey, for topographic surveys and the measurement of streams and other hydrographic and hydrologic works, and for the examination of lands intended to be purchased under this Act, and for any other things required by the board to be done in connection with any investigation or construction done under this Act, three million dollars.

For the Reclamation Service, for the building of irrigation systems to aid in the regulation of the flow of source streams or navigable rivers through the conservation, utilization, and ground storage of waters in irrigated lands, and for the acquisition and reclamation by irrigation or drainage of specific tracts of lands for intensive cultivation and settlement, and for the building of canals and ditches, and carrying to completion any and all methods of utilizing water for irrigation as a means for river regulation, and for any other purpose mentioned or referred to in section fifteen of this Act, ten million dollars.

For the Forest Service, (a) for the protection from fire and insect infestation of national forests, where such protection is essential to the preservation and maintenance of water supplies, and for the acquisition of lands within or near existing national forests or other lands which are necessary to the adequate protection of water supplies, and for building the necessary roads, trails, fire lines, fire-protection stations, telephone lines, and for any and all other things required for such fire protection, including the fighting of fires and the employment of forest guards and rangers, three million dollars.

(b) For the protection from fire of the forested watersheds of navigable streams, for the organization and maintenance of a system of fire protection on any private or State forest lands situated upon the watershed of a navigable river, in cooperation with any State or group of States, as provided for in an Act entitled "An Act to enable any State to cooperate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of rivers," known as the Appalachian National Forest Act, and also in direct cooperation with cities, counties, towns, villages, and other owners of woodlands and forested areas on watersheds, and wherever essential to the preservation of water supplies and for the protection of such forested watersheds and areas from insect infestation, one million dollars.

(c) For the protection, perpetuation, enlargement, maintenance, regulation, and control of water supplies by the establishment and maintenance of forest nurseries, the planting or replanting of forests, the reforestation of denuded areas, the carrying out of silvicultural improvements

in the national forests, and the establishment and maintenance of forest plantations and parks and the acquisition of lands therefor to provide instruction in the planting and care of trees and forests for the purpose of awakening and maintaining a local interest in and knowledge of the relation of forests to the preservation of water supplies and stream flow, one million dollars.

(d) For the acquisition of forest lands by and through the National Forest Reservation Commission as and in the manner provided for in the Appalachian National Forest Act above referred to, subject to all the conditions and requirements contained in said Act, five million dollars.

Provided, That the provisions of the said Appalachian National Forest Act shall, after the expiration thereof by limitation, still continue and be in force with reference to all moneys made available for expenditure thereunder by this Act, either for fire protection or for the acquisition of forest lands.

For the Corps of Engineers, United States Army, for building and maintaining revetments, dykes, walls, levees, embankments, gates, wasteways, by-passes, flood-water canals, restraining dams, impounding basins, and bank-protective works for river regulation, and, as a means to that end, the building of works for reclamation, drainage, and flood protection, and for building reservoirs and artificial lakes and basins for the storage of flood waters to prevent and protect against floods and overflows, erosion of river banks, and breaks in levees, and to regulate the flow of source streams and navigable rivers, and reenforce such flow during drought and low-water periods, and for the operation and maintenance of the same, twenty-four million dollars.

APPENDIX No. 7.

REFERENCES TO FLOOD LITERATURE.

Bibliographies and Indexes — Flood Prediction — Forest Influence — Ice and its Effect — Levees — Reservoirs — Sanitation — American Rivers — Foreign Rivers — General.

This list of flood literature has been compiled by the Technology Department of the Carnegie Library of Pittsburgh, at the suggestion of the Flood Commission of Pittsburgh, to form a guide to the printed matter available on the subject. It covers practically all the useful material in this Library at the present time, November 1, 1911. In its compilation the selection has been restricted closely to the subject indicated by the title. It does not include articles on dams, reservoir construction, river hydraulics, river improvements for purposes of navigation, land reclamation or irrigation, except when specific reference is made to flood abatement.

No attempt has been made to spell titles uniformly, but the spelling of the original has been followed in each case.

The following abbreviations have been used:

diag.	diagrams.	p.	page or pages.
dr.	drawings.	pl.	plates.
ed.	edition.	ser.	series.
ill.	illustrations.	v.	volume.
n. s.	new series.	w.	words.
no.	number.		

BIBLIOGRAPHIES AND INDEXES

The indexes grouped here contain references to many individual streams which it has been impracticable to bring out separately in the general list.

Connor, William D.

Application of the reservoir system to the improvement of the Ohio River. 6,300 w. 1908. (In Engineering News, v. 59, p. 621.)

"References," p. 624.

Floods and inundations. 400 w. 1903. (In Encyclopædia Americana, v.7, under "Floods.")

List of about 50 of the most disastrous floods, A. D. 684–1903.

The same [A. D. 684-1893]. 1901. (In Chamber's encyclopædia, new ed., v. 4, p. 682.)

Hollister, George Buell, & **Leighton,** Marshall Ora.

Passaic flood of 1902. 56 p. 11 diag. 15 pl. 1903. (In United States—Geological survey. Water-supply and irrigation papers, no. 88.)

Index, p. 55–56.

Serious flood in northern New Jersey in February and March, 1902. Region affected contains approximately one-third of the population of the entire state.

"This investigation into the most disastrous flood ever known in the Passaic valley is of timely interest to all classes of citizens dwelling on lowlands subject to floods."—From letter of transmittal.

Hoyt, John C. & **Wood,** B. D.

Index to the hydrographic progress reports of the United States geological survey, 1888 to 1903. 253 p. 1905. (In United States—Geological survey. Water-supply and irrigation papers, no. 119.)

Very full index by names of regions, towns, creeks and rivers. The information indexed is mainly on rainfall, discharge, gage heights and water-power.

Inundation. 1,500 w. 1903. (In New international encyclopædia, v. 10, p. 116.)

"Bibliography," p. 118.

Nature of principal sea and river floods.

McClure, John, comp.

Analytical and topical index to the reports of the chief of engineers and officers of the corps of engineers, United States Army, 1866-1900. 3 v. 1,788 p. 1903.

Volumes 1–2 deal with river and harbor works. Alphabetical arrangement under name of stream or harbor; fully cross-indexed. Gives chronological data relating to each work, usually under the following titles: appropriations, commerce, contracts, engineers, legislation, obstructions, operations, physical characteristics, private work, projects and surveys.

Murphy, Edward Charles.

Destructive floods in the United States in 1903. 81 p. 2 maps. 13 pl. 1904. (In United States—Geological survey. Water supply and irrigation papers, no. 96.)

Index, p. 79–81.

"The year 1903 will long be remembered for its extreme local variations from normal climatic conditions. A cloud burst at Heppner, Oreg...a tornado and an excessive rainfall at Gainesville, Ga...the excessive rainfall...in South Carolina...and tornadoes and excessive rainfall of the upper-central Mississippi valley and lower Missouri valley ...resulted in the destruction of much property."

Murphy, Edward Charles, and others.

Destructive floods in the United States in 1904. 206 p. 19 dr. 18 pl. 1905. (In United States—Geological survey. Water-supply and irrigation papers, no. 147.)

Index p. 195–206.

"The United States Geological survey has carried on a study of the water resources of the country for the past seventeen years and there is now available for the use of engineers and others interested a large mass of data bearing on the seasonal flow of the principal streams of the country. In this paper that part of these data which bears on the maximum rate of run-off of streams is brought together and a method is given for the determination of the waterway area of streams."

Geographical arrangement, usually considering in each section: precipitation, gage height and discharge of rivers, damage, and prevention of future damage.

Murphy, Edward Charles, and others.

Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature. 105 p. 15 maps and pl. 1906. (In United States—Geological survey. Water-supply and irrigation papers, no. 162.)

Index, p. 103–105.

"Index to flood literature," p. 88–101.

"Few lives were lost and the damage was small compared with that of some previous years."

The "Index to flood literature" is a cross-reference list of 14 closely-printed pages. Deals only with floods in the United States and is compiled almost wholly from reports of United States engineers, United States geological survey, and Rafter's "Hydrology of the state of New York." Floods are indexed both by stream and by principal places affected. Largely concerned with flood discharges.

Nelson, Knute, and others.

Report on the Mississippi river floods by the committee on commerce, United States Senate, pursuant to Senate resolution no. 76, 55th congress, 1st session. 522 p. 1 ill. 4 maps. 21 pl. 2 tables. 1898. [published 1899.] (In United States—55th congress, 3d session. Senate report no. 1433, v. 2.)

Index, p. 519–522.

The same, condensed. 2,500 w. (In Engineering news, v. 41, p. 50.)

The same, condensed. 6,500 w. (In Engineering record, v. 39, p. 184.)

Rafter, George W.

Hydrology of the state of New York. 902 p. 74 dr. 5 maps. 45 pl. 99 tables. 1904. [published 1905.] (In New York (state)—Museum. Bulletin no. 85.)

Index, p.885–902.

"List of the works referred to," p. 875–883.

Revision of "Water-supply and Irrigation papers," no.24 and 25, published in 1899. Besides his connection with the United States Geological Survey, the author has conducted investigations for Board of Engineers on Deep Waterways, been consulting engineer to the Canal Committee, and a member of the Water Storage Commission of New York. Since 1900 he has been in general practice as consulting engineer in different states, until at the present time there is hardly a phase of power development or water storage that has not at some time or other been before him for consideration. Condensed from preface.

Under "Maximum and minimum flow of streams," p.422, author deals with cause, frequency, prevention and prediction of floods. Considers separately floods in most of the streams of the state; discusses water-storage projects, etc.

Rafter, George W.

Water resources of the state of New York, pt. 1-2. 200 p. 3 diag. 4 maps. 25 pl. 1898. [published 1899.] (In United States—Geological survey. Water-supply and irrigation papers, no. 24-25.)

Index, p.199–200.

Revision published as "Hydrology of the state of New York."

Russell, Thomas.

Floods. 4,500 w. 1893. (In Johnson's universal cyclopædia, v. 3, p. 421.)

"References," p.423.

The same, 1902. (In same, new ed. [Universal cyclopædia and atlas], v. 4, p. 393.)

"References," p.395.

Coastal floods, reservoir floods, river floods, run-off levees, mode of occurrence of high water, forests, records of river stages, flood-wave movement, river-stage predictions, rainfall and river rise.

United States—Library of Congress.

List of works relating to deep waterways from the Great lakes to the Atlantic ocean, with some other related works. 59 p. 1908.

Includes books (with alphabetical arrangement by authors), articles in periodicals (with chronological arrangement, 1887–1908), congressional documents (with chronological arrangement, 1808–1907). The references to books and documents have full titles and in many cases tables of contents or explanatory notes.
A few of the articles and documents deal with flood abatement.

United States—Weather bureau.

Work of the Weather bureau in connection with the rivers of the United States. 106 p. 3 diag. 1896. (In United States—Weather bureau. Bulletin no. 17.)

"Contents," p.11.
"Work...is to facilitate commerce...by publishing daily information as to water stages along the course of each river, and to issue timely warnings of floods so as to effect the saving of life and property." Introduction.
Value of the service, system of warnings, tables of distances, river tributaries, rate of flood movement, and notes on rivers and floods in various sections.

Walford, Cornelius.

Famines of the world, past and present. 103 p. 1878. (In Journal of the Statistical Society [London], v. 41, p. 433.)

Table 2 (p.451–468) gives a chronological list with considerable information on floods from the deluge to A. D. 1878.

Wilson, Herbert M.

Irrigation in India. Ed. 2. 238 p. 93 dr. and ill. 1903. (In United States—Geological survey. Water-supply and irrigation papers, no. 87.)

Index, p.227–238.
"List of works on Indian irrigation," p.25–28.
Chapter 9, p.221, deals briefly with precautions against floods: bank protection by means of earth groins and by planting of water-grass to retain silt.

FLOOD PREDICTION

See also Foreign Rivers (French, German)

Allard, E.

Note sur la prévision des crues. 57 p. 1 folding pl. 1889. (In Annales des ponts et chaussées mémoires, ser.6, v.17, p.629.)

The same, condensed translation. 300 w. (In Minutes of proceeding of the Institution of Civil Engineers, v. 99, p. 432.)

Daily prediction of river heights can be only approximated at present, but will doubtless be rendered more accurate by further researches. Several tables relate to flood prediction in the Seine valley.

Babinet.

Situation actuelle des étude et des annonces des crues dans les principaux bassins français. 1,600 w. 1903. (In Annales des ponts et chaussées, mémoires, ser.8, v.10, p.222.)

Work of flood prediction was established in France about 1850. Author has been connected with this work for more than five years.

Breuille, P.

Etude sur la prévision des crues de l'Yonne, du Serein et de l'Armançon. 29 p. 1896. (In Annales des ponts et chaussées, mémoires, ser.7, v. 12, p. 128.)

Byers, Charles Alma.

Our flood-warning service. 1,200 w. 1904. (In Scientific American supplement, v. 57, p. 23651.)

Review of river and flood service of United States weather bureau, in regard to its growth, its plan of action and what it is accomplishing.

Frankenfield, H. C.

Floods and flood warnings. 3,500 w. 1902. (In United States—Department of agriculture. Yearbook, 1901, p. 477.)

Harcourt, Leveson Francis Vernon.

Prediction of floods; and protection from inundations. 24 p. 1896. (In his Rivers and canals, v.1, p.148.)

Holtz.

Note sur l'annonce des crues de l'Elbe in Bohème. 2,800 w. 1 map. 1 folding pl. 1891. (In Annales des ponts et chaussées, mémoires, ser. 7, v.1, p. 477.)

Discharge of tributaries is measured and method of prediction explained.

Hyatt, R. J.

River and flood service. 400 w. 1898. (In United States—Weather bureau, Bulletin no.24, p.50.)

Describes work of United States weather bureau.

Mahan, Fr. & **Lemoine,** G.

Sur l'annonce des crues de l'Ohio. 2,500 w. 1 map. 1884. (In Annales des ponts et chaussées, memoires, ser.6, v.8, p.487.)

Plan for flood prediction somewhat similar to one in use on Seine. Based on daily communication with Cincinnati by telegraph from principal river cities and by mail from less important points.

Mazoyer.

Note sur le service de la prévision des crues dans la Loire central. 72 p. 4 diag. 2 folding pl. 1890. (In Annales des ponts et chaussées, mémoires, ser.6, v.20, p.441.)

Graphic representation of the three types of floods met with. Explanation of two methods of prediction. Many tables.

Outram, T. S.

Warnings of washouts, floods, cold waves, and heavy snowfalls, for the benefit of transportation companies. 900 w. 1898. (In United States—Weather bureau. Bulletin no.24, p.38.)

Pindell, L. M.

River and flood service. 400 w. 1898. (In United States—Weather bureau. Bulletin no.24, p.51.)

Voisin.

Mémoire sur l'organisation et le fonctionnement du service hydrométrique et d'annonce des crues du bassin de la Liane. 37 p. 3 folding pl. 1888. (In Annales des ponts et chaussées, mémoires, ser. 6, v.15, p.464.)

The same, condensed translation. (In Minutes of proceedings of the Institution of Civil Engineers, v.93, p.516.)

"It is possible...in a basin of small extent, by means of careful observations of the rainfall, and the rise of the river in the upper portion of the valley, to predict with adequate correctness the rise of the river at points lower down."

FOREST INFLUENCE

Beardsley, R. C.

Forests and stream flow. 2 diag. 2,000 w. 1910. (In Engineering news, v.63, p.255.)

Letter criticizing report of National Conservation Commission in "Water-supply paper" 234 of the United States geological survey. Author dissents from the opinion that floods are due to deforestation and believes that an important cause of floods is the drainage of swamps.

Castle, Mildred A. tr.

Effect of the forest upon waters. 9 p. 1910. (In American forestry, v.16, p.156.)

Translated from "Revue des eaux et forets," Jan. 1, 15, 1909.
Results of American and European researches, discussing papers at Eleventh International Congress of Navigation at Milan, 1905, and other literature. Bibliographic foot-notes.

Chittenden, Hiram Martin.

Forests and floods; extracts from an Austrian report on floods of the Danube, with applications to American conditions. 6,400 w. 1908. (In Engineering news, v.60, p.467.)

Discussion of paper by Ernst Lauda, chief of the hydrographic bureau of the Austrian government. Lauda's paper "gives the most complete chronological record of the Danube floods, that has ever been prepared for that or probably any other stream."

Chittenden, Hiram Martin, and others.

Forests and reservoirs in their relation to stream flow, with particular reference to navigable rivers, with discussion by F. Collingwood [and others.]. 300 p. ill. 1909.

Reprinted from the "Transactions of the American Society of Civil Engineers," v.62.

The same. 1909. (In Transactions of the American Society of Civil Engineers, v.62, p.245.)

"Municipalities like Pittsburgh, Cincinnati and Kansas City, must look in the main to their own efforts for protection against floods. In particular, they must reject absolutely the delusive promises of forestry." Conclusion, p.315.

Chittenden, Hiram Martin.

Forests, stream flow and storage reservoirs. 500 w. 1908. (In Engineering news, v.60, p.564.)

Letter in support of article in "Engineering news," v.60, p.467.

Fenn, F. A.

The national forests. 900 w. 1910. (In American forestry, v.16, p.187.)

General discussion of national forests and stream protection. Author is a supervisor in the United States forest service.

Finney, John H.

Connection between forests and streams. 1,000 w. 1910. (In American forestry, v.16, p.109.)

Criticism of Moore's conclusions by secretary of the Appalachian National Forest Association.

Forest preservation and flood prevention. 700 w. 1903. (In Engineering news, v.49, p.324.)

Editorial stating that forests do not increase rainfall and that they exert no appreciable influence on flood heights. See Lippincott for criticism.

Forests and streamflow. 3,500 w. 1911. (In American forestry, v.17, p.403.)

Discusses recent literature on this subject, and describes briefly the experimental station at Wagon Wheel Gap in the Rio Grande national forest. This station is to be controlled jointly by the Forest service and the Weather bureau, the object being to determine the effect of forest cover upon high and low water stages of mountain streams, the run-off of mountain watersheds as compared with annual precipitation and the erosion of the surface of the watershed. The only similar experiments heretofore made have been in Switzerland.

Fox, William F.

Why our forests should be preserved and protected. 2,200 w. 1 ill. 1897. [published 1898.] (In New York (state)—Commissioners of fisheries, game and forests, v.3, p.327.)

Gives briefly the various arguments, one being flood prevention.

Glenn, L. C.

Forests as factors in stream flow. 3,000 w. 2 ill. 1910. (In American forestry, v.16, p.217.)

Hall, William L. and **Maxwell,** Hu.

Surface conditions and stream flow. 16 p. 1910. (United States—Forestry bureau. Circular 176.)

The same, abstract. 3,500 w. 1911. (In American forestry, v. 17, p.371.)

Study of the tendency toward increased floods and the causes, considering precipitation, evaporation, temperature, topography and geology, natural and artificial reservoirs, soil, ground cover, and general watershed conditions. States that "undoubtedly it is the clearing away of the forests on the mountainous watersheds of the streams...described that has caused the great increase in frequency and duration of floods."

Harts, William W.

Relation of forests to stream flow. 2,500 w. 1910. (In Engineering news, v.63, p.245.)

From "Professional memoirs," Engineer bureau, United States army, Oct.–Dec., 1909.

Careful study of record relating to the two principal rivers under author's supervision: the Cumberland and the Tennessee. These records cover approximately 40 years and author claims there is but slight indication of the influence of forests and the little evidence found is adverse to the forests.

Johnson, Clarence T.

Effect of forests on floods in large streams. 200 w. 1903. (In Engineering news, v.49, p.369.)

Letter expressing the opinion that forests have slight effect on floods, and maintaining the impracticability of controlling the discharge of large streams by means of storage reservoirs.

Leighton, Marshall Ora, & **Horton,** A. H.

Relation of the southern Appalachian mountains to inland water navigation. 38 p. 1908. (In United States—Forestry bureau. Circular no.143.)

In connection with the agricultural appropriation bill, on March 4, 1907, Congress authorized the secretary of agriculture to examine and report on the natural condition of watersheds in the southern Appalachian and the White mountains. Because of its identification with studies of stream flow and its facilities for stream measurement, arrangement was made with the United States Geological Survey for a study of the water resources of the southern Appalachian mountains. This report is the result.

Considers rivers which drain into the Atlantic and rivers which drain into the Ohio.

"In conclusion, the figures given in this report bear out the statement...that the proper improvement of many rivers may be practically and thoroughly accomplished only by the use of storage reservoirs and the retention of the forest cover...The second important point brought out...is that conservation of stream flow depends upon the condition of the drainage area and that to insure the perpetuation of the proper conditions it is necessary to preserve the forests and keep the land surfaces intact."

Lippincott, J. B.

Effect of forests on flood heights. 1,000 w. 2 diag. 1903. (In Engineering news, v.49, p.478.)

Discussion of a recent editorial on "Forest preservation." Presents data to show importance of forests in flood prevention.

Moore, Willis L.

Report on the influence of forests on climate and on floods. 38 p. 2 diag. 3 charts. 1910.

Report to Committee on agriculture of the House of representatives.

The same, condensed. 10,000 w. (In Engineering news, v.63, p.245.)

Conclusions:

"(1) Any marked climatic changes that may have taken place are of wide extent and not local, are appreciable only when measured in geologic periods, and evidence is strong that the cutting away of the forests has had nothing to do with the creating or the augmenting of droughts in any part of the world.

(2) Precipitation controls forestation, but forestation has little or no effect upon precipitation.

(3) Any local modification of temperature and humidity caused by the presence or absence of forest covering, the building of villages and cities, etc., could not extend upward more than a few hundred feet, and in this stratum of air saturation rarely occurs, even during a rainfall, whereas precipitation is the result of conditions that exist at such altitudes as not to be controlled or affected by the small thermal irregularities of the surface air.

(4) During the period of accurate observations, the amount of precipitation has not increased or decreased to an extent worthy of consideration.

(5) Floods are caused by excessive precipitation, and the source of the precipitation over the central and eastern portions of the United States is the vapor borne by the warm southerly winds from the Gulf of Mexico and the adjacent ocean into the interior of the country, but little from the Pacific ocean crossing the Rocky mountains.

(6) Compared with the total area of a given watershed, that of the headwaters is usually small, and except locally in mountain streams, their run-off would not be sufficient to cause floods, even if deforestation allowed a greater and quicker run-off. Granting for the sake of argument that deforestation might be responsible for general floods over a watershed, it would be necessary, in order to prevent them, to reforest the lower levels with their vastly greater areas, an impossibility unless valuable agricultural lands are to be abandoned as food-producing areas.

(7) The run-off of our rivers is not materially affected by any other factor than the precipitation.

(8) The high waters are not higher, and the low waters are not lower than formerly. In fact, there appears to be a tendency in late years toward a slightly better low-water flow in summer.

(9) Floods are not of greater frequency and longer duration than formerly."

Oswald, Felix L.

Floods and their causes, 2,000 w. 1889. (In Lippincott's monthly magazine, v.44, p.237.)

Brief description of conditions in many parts of the world. Concludes that "the affliction of river-floods in their chronic and infinitely more pernicious form is caused almost exclusively by the disappearance of arboreal vegetation, and especially by the destruction of the land-protecting highland forests."

Rafter, George W.

Natural and artificial forest reservoirs of the state of New York. 24,000 w. 6 ill. 1 map. 1897. [published 1898.] (In New York (state)—Commissioners of fisheries, game and forests, v.3, p.372.)

"Why forests conserve stream flow," p.407.
Has slight reference to flood prevention.

Relation of forests to stream flow. 2,500 w 1908. (In Engineering news, v.60, p.478.)

Editorial discussion of Chittenden's papers in "Engineering news," v.60, p.467, and in "Transactions of the American Society of Civil Engineers, " v.62, p. 245.

Report of Mr. Moore. 700 w. 1910. (In American forestry, v.16, p.184.)

Editorial, criticizing views of Moore.

Roberts, Thomas Paschall.

Is the destruction of forests a cause for the increase in the frequency and height of floods? 7,000 w. 2 folding pl. 8 tables. 1884. (In Proceedings of the Engineers' Society of Western Pennsylvania, v.2, p.285.)

The same, abstract. 600 w. (In Minutes of proceedings of the Institution of Civil Engineers. v.79, p.407.)

Discussion, 3,500 w.
Contains criticism of a treatise by Gustav Ritter von Wex on "Decrease of water in springs...contemporaneously with an increase in height of floods." Author concludes that destruction of forests does not lead to increased height of floods. His views are supported by the discussion. Tables show rainfall, river stage, and flood records, both in the United States and Germany.

Roth, Filibert.

Appalachian forests and the Moore report. 3,200 w. 3 ill. 1910. (In American forestry, v. 16, p.209.)

Author is professor of forestry in University of Michigan.
Criticism of Moore's report to Committee on agriculture.

Rothrock, Joseph T.

Pennsylvania forests and what is necessary to their restoration. 7,000 w. 1901. (In Proceedings of the Engineers' Club of Philadelphia, v.18, p.79.)

Discussion, 3,000 w.
"Unless by some means the even flow of water in our streams is maintained, our agricultural interests will be seriously injured...Of all the helpful forces which we can control to accomplish this there is nothing so potent as a proper proportion of forest land."

Rothrock, Joseph T.

Some observations on forests and water-flow. 1,200 w. 1910. (In American forestry, v.16, p.349.)

Discussion of influence of forests on water flow during winter, claiming that the effect is to retard run-off. Refers to report by Moore.

Seely, Leslie B.

Some problems of forestry. 9,000 w. 1909. (In Journal of the Franklin Institute, v.168, p.1.)

Discusses influence of forests on general precipitation, influence on drainage, etc. Gives results of observations in India, in Bohemia and in California. These observations, however, cover only brief periods. Attributes both drought and floods largely to deforestation. Characterizes Pittsburgh as the "flood city."

Swain, George F.

Influence of forests on climate and on floods. 7,000 w. 2 ill. 1910. (In American forestry. v.16, p.224.)

See also note, p.315.

The same. (In Engineering news, v.63, p.427.)

Author is professor of civil engineering, Harvard University.
Lengthy criticism of Moore's report to the Committee on agriculture of the House of representatives. Author believes that deforestation unquestionably "increases the number and suddenness of floods, diminishing also their duration."

T., A.

Le reboisement des montagnes. 2,000 w. 7 ill. 1903. (In Génie civil, v. 43, p.337.)

Means of dealing with mountain torrents in France by artificial barrages, etc. Emphasizes importance of forest preservation and restoration, showing how this work is encouraged by the government.

Wilson, Elwood.

Relation of forests to stream flow in Quebec. 300 w. 1908. (In Engineering news, v.60, p. 564.)

Letter differing with conclusions of Chittenden in his article in "Engineering news," v.60, p.467.

ICE AND ITS EFFECT

See also American Rivers (Susquehanna; Other rivers, Traill).—Foreign Rivers (Miscellaneous, Ritter von Wex).

Barnes, Howard T.

Ice formation, with special reference to anchor ice and frazil. 260 p. Ill. 1906.

Considerable information on ice-floods of the St. Lawrence. See index under "Floods."

Flood damages to the Hudson river passenger bridge and station of the Delaware & Hudson Ry. at Albany, N. Y. 900 w. 4 ill. 1900. (In Engineering news, v.43, p.132.)

Bridge under construction. Falsework of draw span was partly destroyed by ice jam, in spite of protection by a system of fender piles.

Gorz, M. & **Buchheister,** M.

Das eisbrechwesen im Deutschen Reich. 248 p. 46 pl. 1900.

Describes first the formation of ice on rivers and canals, reasons for removing it, including floods and breaking of dikes, and methods used in various parts of Germany before ice-breaking steamers were introduced. The construction of such boats and their accessories is then considered. Concludes with a description of methods and cost of breaking ice and the results obtained. Numerous maps and drawings of ice-breakers.

Henshaw, George H.

Frazil ice; on its nature and the prevention of its action in causing floods. 2,800 w. 1887. (In Transactions of the Canadian Society of Civil Engineers, v.1, p.1.)

Discussion, 6,400 w.

"Author's object is to ...suggest a method of dealing with it, so as to prevent its more than suspected agency in producing floods." Recommends straightening of channels, clearing away of boulders and other elevations. Endorses the idea of ice-breaking vessels recommended by Government Commission on floods.

LEVEES

See also American Rivers (Colorado, Mississippi).

Bayley, George W. R.

Levees as a system for reclaiming lowlands. 16,000 w. 1875. (In Transactions of the American Society of Civil Engineers, v.5, p.115.)

Land reclamation and flood control, with special reference to the Mississippi river. "Its flood can be controlled by means of a levee system, but only the national government is able to perfect and maintain such...Levees can be relied upon, and levees alone can be...Cut-offs should be prevented wherever possible...Reservoirs are impracticable...As to the diversion of tributaries, it would be useless even if practicable."

See also Forshey, discussion, p.299.

Closing a crevasse in a Louisiana levee. 1,200 w. 1903. (In Engineering news, v.49, p.419.)

From New Orleans "Times-democrat."
Crevasse of Sunday, April 5, 1903, closed by the following Thursday.
See also letter, p.454.

Coppee, H. St. L.

Standard levee sections. 46 p. 126 dr. 2 ill. 1898. (In Transactions of the American Society of Civil Engineers, v.39, p.191.)

With discussion and correspondence.
Compares practice on lower Mississippi with foreign practice and with early work in America.

Cory, H. T.

Gravel spreader used on the Colorado river levee construction. 1,100 w. 2 dr. 4 ill. 1907. (In Engineering news, v.58, p.25.)

To protect newly constructed levees against erosion by high velocity of water and against burrowing by animals and insects it was decided to blanket the system with a cementing gravel. Distribution of gravel is described.

Cost of riprap paving, brush mattresses and brush dikes for a levee protection. 1,000 w. 1907. (In Engineering-contracting, v.27, p.242.)

Figures on construction of West pass levee, Mississippi.

Dumas, A.

Construction des digues en terre par la méthode anglaise. 2,000 w. 3 ill. 1899. (In Génie civil, v.36, p.71.)

Comparison with French construction.

Forshey, Caleb G.

Delta of the Mississippi; the physics of the river, the control of its floods and the redemption of the alluvion. 33 p. 1872. (In Proceedings of the American Association for the Advancement of Science, v.21, p.78.)

Plea for a better system of levees. Argues that the problem is national in character and cannot be solved by the states alone. Includes history of Mississippi levees.

Forshey, Caleb G.

Levees of the Mississippi river. 9,000 w. 7 ill. 1874. (In Transactions of the American Society of Civil Engineers, v.3, p.267.)

From a paper presented May 22, 1873.
History, form, dimensions and essentials.

Forshey, Caleb G.

On levees. 9,000 w. 1876. (In Transactions of the American Society of Civil Engineers, v.5, p.299.)

Discussion of paper by Bayley, dealing mainly with the Mississippi.
Maintains that levees tend to produce enlargement of channel capacity, that cut-offs have been too numerous and should be abandoned as a method of flood control.

Galliot.

Le corroyage des digues en terre. 6,500 w. 1902. (In Annales des ponts et chaussées, mémoires, ser.8, v.3, p.196.)

Great question of levees. 700 w. 1903. (In American architect and building news, v.81, p.14.)

From New Orleans "Times-democrat."
Favors better levees on lower Mississippi. Gives statistics of crevasses.

Hardy.

Etude sur les endiguements de la Durance dans le départment de Vaucluse et dans la commune de Pertuis en particulier. 8,000 w. 1 folding pl. 1875. (In Annales des ponts et chaussées, mémoires, ser. 5, v.11, p.518.)

The same, condensed translation. 800 w. (In minutes of proceedings of the Institution of Civil Engineers, v.46, p.297.)

First combined action of landowners was in 1808. Expense of embankment to be borne by proprietors of adjacent land, aided by government grant of one-third of the cost. Work still in progress in 1875. Construction of dikes is given.

Helm, Edwin G.

Levee and drainage problem of the American bottoms. 26 p. 1 folding pl. 1905. (In Journal of the Association of Engineering Societies, v.35, p.91.)

Protection from overflow by the Mississippi in that part of the valley which lies between river and foot of bluffs in Madison and St. Clair counties, Ill.

Kerr, Frank M.

Levees, with special reference to the Red river system. 7,000 w. 1898. (In Journal of the Association of Engineering Societies, v.21, p.295.)

The same, abstract. 1,800 w. (In Engineering news, v.39, p.309.)

Account of the work then in progress and its aim.

Levee and drainage works at Memphis. 4,500 w. 7 dr. 2 ill. 1906. (In Engineering record, v.53, p.496.)

System for protection of 110 acres near business section from backwater during Mississippi floods. Describes levees, low-level sewers, and pumping station for storm water. Gives costs.

Levee construction. 700 w. 1889. (In Engineering news, v.22, p.441.)

Methods adopted by Board of Mississippi Levee Commissioners and their chief engineer.

Levee theory on the Mississippi river; is it justified by experience? 84 p. 5 diag. 1903. (In Transactions of the American Society of Civil Engineers, v.51, p.331.)

Informal discussion by Messrs. B. M. Harrod, L. W. Brown, J. A. Ockerson, L. M. Haupt, B. F. Thomas, H. B. Richardson and T. G. Dabney.

McMath, Robert E.

Levees; their relation to river physics. 4,500 w. 4 diag. 1884. (In Journal of the Association of Engineering Societies, v.3, p.43.)

With reference to the Mississippi.
"Levees can never be made safe as a protection against overflow in a river carrying large quantities of silt. The physical action of levees has also been seen to provoke silt movement, and therefore to increase the very evil they profess to guard against."

Mississippi flood and the levee system. 1,200 w. 1903. (In Engineering news, v.49, p.276.)

Editorial calling attention to unintelligent newspaper criticism of levee system. Considers flood of 1903 additional proof of the value of levees.

Mississippi levees and the flood. 2,200 w. 1897. (In Railroad gazette, v.29, p.619, 622.)

Extract from letter of Richardson. Considers percentage of levee that failed, efficiency of levee protection, grades, proper cross-section, settling and maintenance.

Mount, Mary W.

New methods for closing a crevasse in a Mississippi river levee; the Live Oak crevasse, Louisiana. 2,100 w. 5 ill. 1907. (In Engineering news, v.58, p.431.)

Said to be the first case in which track was laid on bridge work across break; also new methods of pile bracing and sheeting. Earth-filled sugar sacks were used for filling.

Ozias, C. W.

Construction of the levee below the recent Colorado river break. 1,700 w. 7 ill. 1907. (In Engineering news, v.57, p.545.)

Author is assistant engineer, United States reclamation service, lent to California Development Co. to assist in constructing the levee.

Pharr, Harry N.

St. Francis levee districts of Arkansas and Missouri. 5,000 w. 2 maps. 1902. (In Engineering news, v.47, p.24.)

Favors levee system for flood protection. Admits the advantages of reservoir systems for some Western rivers, but believes that for the Mississippi they would be impracticable, as also would channel rectification, water diversion and outlet methods.

Rundall, F. H.

[Disposal of flood waters.] 400 w. 1880. (In Minutes of proceedings of the Institution of Civil Engineers, v.80, p.130.)

In a discussion on "Weirs" author argues that embanking of rivers does not cause rise of beds.

Starling, William.

Levees of the Mississippi river. 12,300 w. 11 ill. 1 map. 1896. (In Engineering news, v.35, p.66, 77.)

Describes in detail the construction and maintenance of levees, the nature of crevasses and methods of repair.

State levees of Louisiana. 1,200 w. 1898. (In Engineering record, v.38, p.353.)

Editorial on extent and cost. There are (1898) 1,194 miles of levee in Louisiana and 90 miles in Arkansas.

RESERVOIRS

See also American Rivers (Mississippi; Ohio and Branches.—Forest Influence).

Chittenden, Hiram M.

Preliminary examination of reservoir sites in Wyoming and Colorado. 110 p. 25 ill. 1 map. 10 folding pl. 1897. (In United States—55th congress, 2d session. House document no.141.)

Index, p.105–110.

The same. (In United States—Engineer department. Report, 1898, pt.4, p.2815.)

Some consideration of floods in the United States and abroad.

Grant, Kenneth C.

Regulation of the Wien river at Vienna, Austria. 7 p. 3 dr. 1911. (In Journal of the Engineers' Society of Pennsylvania, v.3, p.255.)

Describes straightening and walling up of channel and construction of seven small reservoirs for flood control.

Gros.

Note sur l'insuffisance des réservoirs pour atténuer le danger des inondations. 3,600 w. 1881. (In Annales des ponts et chaussées, mémoires, ser.6, v.2, p.5.)

The same, condensed translation. 800 w. (In Engineering news, v.25, p.258.)

The same, condensed translation. 600 w. (In Minutes of proceedings of the Institution of Civil Engineers, v.66, p.408.)

Investigations in valleys of Seine, Rhone, Loire, Garonne and other important rivers led to decision against proposed reservoir systems, owing to their doubtful efficacy. Reservoirs on tributaries, by retarding the floods, might be injurious. Flood reservoirs cannot safely be used for irrigation, canal supply, etc., as they should be kept empty during entire flood season. Urges abandonment of all reservoirs.

Harwood, W. S.

Great reservoir system of the upper Mississippi. 4,000 w. 1 map. 1897. (In Harper's weekly, v.41, pt.1, p.38.)

Chief benefit is said to be prevention of floods or reduction of their intensity. Others are irrigation; more uniform water distribution for power purposes and navigation; improvement in quality of domestic water-supply during low water.

Pyle, J. G.

Reservoir system. 4,000 w. 3 dr. 1 map. 1884. (In Harper's monthly magazine, v.69, p.616.)

Describes system already begun, which contemplates the erection of five dams on the upper Mississippi proper and others on its upper tributaries.

Seddon, James A.

Monograph...on reservoirs and their effects on floods of Mississippi system. 31 p. 2 pl. 1898. (In United States—Engineer department. Report, 1898, pt.4, p.2887.)

The same. (In United States—55th congress. 2d session. House document 141, p.73.)

Forms appendix C to report of Chittendon. A careful study of river discharge, flood stages, etc., for the six years 1880–85. Considers separately (1) The Mississippi and its tributaries above Cairo; (2) The lower Mississippi.

Seddon, James A.

Reservoirs and the control of the lower Mississippi. 62 p. 4 folding pl. 1900. (In Journal of the Western Society of Engineers, v.5, p.259.)

The same, abstract. 5,500 w. 1 map. (In Engineering news, v.44, p.293, 296.)

Discussion.

Proposes the construction in the St. Francis basin of the lower Mississippi (a low-land tract in southeastern Missouri and northeastern Arkansas) of a system of shallow reservoirs into which flood water could be diverted, to be turned back to the river during low water. These reservoirs are planned to cover about 4,000 sq. mi. with an average depth of 15½ ft. Estimated cost, $32,000,000.

See also Townsend.

Townsend, Maj. C. McD.

Reservoirs and the control of the lower Mississippi. 6,400 w. 6 folding pl. 1901. (In Journal of the Western Society of Engineers, v.6, p.146.)

Discussion of paper by Seddon on above subject. Agrees with many of the views expressed, but questions the economy of reservoir construction as contrasted with improved levee system. Final remarks by Seddon claim for reservoirs an advantage in cost of maintenance and in safety.

SANITATION

See also American Rivers (Ohio and branches, Easton).

Cleansing and disinfecting dwellings after the Paris floods. 300 w. 1910. (In Engineering news, v.63, p.352.)

Translated from "La Technique sanitaire," Feb., 1910.

Groff, George G.

How sickness was prevented at Johnstown. 2,600 w. 1890. (In Chautauquan, v.10, p.563.)

Work done by State board of health, of which author is a member, aids to state work and lessons for the future.

Pennsylvania—Health Board.

Operations of the Board of health in consequence of the floods at Johnstown of May 31, 1889. 134 p. 1891.

Johnstown and the valleys of the Conemaugh, Kiskiminetas, Allegheny and Ohio.—West Branch of the Susquehanna.—The Susquehanna.—The Juniata.

Appendix E to the fifth annual report of the State board of health.

Sanitary precautions after floods. 600 w. 1883. (In American architect and building news, v.13, p.297.)

Sanitation of houses in France. Instructions from Comité consultatif d'hygiène publique, June 12, 1856, and from Conseil d'hygiène publique, etc., de salubrité du Departement de la Seine, Jan. 5, 1883.

Soper, George A.

Sanitary cleaning of Galveston after the great storm of 1900. 1,800 w. 1901. (In Engineering news, v.45, p.301.)

Extracts from report to New York Chamber of Commerce. Gives results accomplished and suggestions for continuing sanitation.

Soper, George A.

Sanitary measures to be adopted after floods. 2,600 w. 1902. (In Scientific American supplement, v.53, p.22118.)

From "American journal of the medical sciences."
Importance of precautions in regard to food and water-supply, disinfectants, refuse disposal, cleaning of premises and repairing of damages.

AMERICAN RIVERS. FLOODS AND METHODS OF FLOOD RELIEF.

See also Bibliographies and Indexes (Murphy).

Brazos

Hutson, William Ferguson.

Brazos river flood. 600 w. 6 ill. 1 map. 1899. (In Harper's weekly, v.43, pt.2, p.750.)

Texas flood of June–July, 1899, "the third flood of importance in this section."

Texas floods. 200 w. 1899. (In Chautauquan, v.29, p.504.)

Estimates of damage in Brazos river flood, June–July, 1899.

Texas floods. 400 w. 1899. (In Independent, v.51, pt.2A, p.1852.)

Brazos river flood, June–July, 1899.

Colorado

Break of the Colorado river into the Imperial valley and Salton sink. 3.500 w. 2 dr. 1 map. 1906. (In Engineering news, v.55, p.216.)

Attempt to tap the Colorado by an irrigating ditch led to diversion of most of the river and inundation of the Salton sink or basin, which is below sea-level.
Describes also attempts at checking of flow, by Southern Pacific Company.

Byers, Charles Alma.

Possibilities of Salton sea. 2,800 w. 19 ill. 1 map. 1907. (In Popular science monthly, v.70, p.5.)

Some probable consequences of failure to restore river to old channel. Agrees however that value of the land and its products far outweighs the possible benefits of such an inland lake. Reviews the first six attempts at closure, none of which was successful.

Closing latest break of the Colorado river into the Salton sea. 800 w. 10 ill. 1 map. 1907. (In Railroad gazette, v.42, p.217.)

Crevasse caused by water undermining the levee previously constructed.

Colorado river crevasse and Salton sea; the great work of control. 2,000 w. 2 maps. 1906. (In Railway age, v.42, p.547.)

Outlines six attempted methods of control.

Controlling the Colorado river and the Salton sea. 2,000 w. 6 ill. 3 maps. 1906. (In Scientific American, v.109, n. s. v.95, p.467.)

Cory, H. T.

Closing the break of the Colorado river into the Salton sink, southern California. 5,500 w. 3 maps. 1906. (In Engineering news, v.56, p.671.)

Describes briefly the six attempts, the last of which was then thought to be successful. Gives statistical summary of the work. Author is general manager and chief engineer of the California Development Co.

Cory, H. T.

Closing the new break in the Colorado river. 3,200 w. 6 ill. 2 maps, 1907. (In Engineering record, v.55, p.293.)

Cory, H. T.

Colorado river crevasse and Salton sea. 2,600 w. 1 diag. 5 ill. 5 maps. (In Railway age, v.43, p.953.)

Deals largely with effect on Southern Pacific lines and work of this railway company in controlling the river.

Davis, Arthur P.

New inland sea. 4,500 w. 8 ill. 1 map. 1907. (In National geographic magazine, v.18, p.37.)

Describes break of the Colorado river into Salton sea, and attempts to regain control of the river.

Day, Allen.

Inundation of the Salton basin by the Colorado river, and how it was caused. 1,600 w. 9 ill. 1 map. 1906. (In Scientific American, v.108, n. s. v.94, p.310.)

Grunsky, C. E.
Lower Colorado river and the Salton basin. 51 p. 18 ill. 6 maps. (In Transactions of the American Society of Civil Engineers, v.59, p.1.)

Discussion, 11 p.
History, topography and improvements of the region; the crevasse and its attempted repair.

Grunsky, C. E.
Lower Colorado river during and after the freshet stage of 1907. 1,600 w. 1 map. 1908. (In Engineering news, v.59, p.410.)

Foot-note gives a list of papers in former issues of the "Engineering news" on the Colorado river break.

James, George Wharton.
Overflow of the Colorado river and the Salton sea. 1,800 w. 2 dr. 9 ill. 1906. (In Scientific American, v.108, n. s. v.94, p.328.)

Destructive work of the flood and remedial measures.

Notes on closing the break in the Colorado river. 2,800 w. 7 ill. 1 map. 1907. (In Engineering news, v.57, p.210, 216.)

Ockerson, J. A.
Diversion of the Colorado river into the Salton sink and the efforts made to restore it to its former channel. 3,600 w. 9 ill. 2 maps. 1907. (In Journal of the Association of Engineering Societies, v.38, p.261.)

Rockwood, C. R. & **Ellison**, C. H.
Colorado river crevasse; Salton sea; Southern Pacific tracks. 5,000 w. 1 diag. 2 maps. 1906. (In Railway age, v.41, p.420.)

Causes of flood and results of efforts to check it. New line construction with increased mileage necessitated on Southern Pacific.

Schuyler, James D.
Reinforced concrete and steel headgates for the Imperial canal, Colorado river. 900 w. 3 ill. 1906. (In Engineering news, v.56, p.675.)

Massive construction having large capacity.
See on this page telegraphic correspondence of President Roosevelt and E. H. Harriman relative to closing of break. 500 w.

Story of Salton sea. 5,000 w. 3 maps. 1907. (In Builder, v.93, p.211, 237.)

Washington, W. D. H.
Colorado river closure. 3,000 w. 16 ill. 1 map. 1907. (In Scientific American, v.110, n. s. v.96, p.374.)

Causes and effects of break, and attempted methods of repair.

Conemaugh

See also Sanitation.

Beale, David J.
Through the Johnstown flood, by a survivor. 424 p. 32 ill. 1890.

Connelly, Frank, & **Jenks**, George C.
Official history of the Johnstown flood. 252 p. 18 ill. 1889.

Ferris, George T.
Complete history of the Johnstown and Conemaugh valley flood, embracing also a history of the floods in Williamsport, Lock Haven, Sunbury and all the flooded districts in the state of Pennsylvania; also in Washington, D. C., New York, Maryland, Virginia and West Virginia. 522 p. 48 ill. 1889.

Flagg, J. F.
Velocity of flow in the South Fork spillway. 400 w. 1889. (In Engineering news, v.22, p.41.)

Letter, with editorial comment.

Francis, James B. and others.
Report of committee on the cause of the failure of the South Fork dam. 19,500 w. 11 ill. 7 folding pl. 1890. (In Transactions of the American Society of Civil Engineers, v.24, p.431.)

With discussion.

General discussion of the discharge of streams. 5,000 w. 1 map. 1902. (In Proceedings of the Engineers' Club of Philadelphia, v. 19, p.205.)

Floods and flood protection, considering rivers in Pennsylvania only. Map shows South Fork dam and Johnstown region.

Jennings, William N.

Through the Conemaugh valley; a series of photographs showing the destructive effects of the flood of May 31, 1889, along the line of the Pennsylvania railroad; printed from original negatives. 21 pl. 1889.

Photographs of Johnstown flood, with blue print of the region showing location of the views.

Johnson, Willis Fletcher.

History of the Johnstown flood...with full accounts also of the destruction on the Susquehanna and Juniata rivers and the Bald Eagle creek. 459 p. Ill. 1889.

Johnstown disaster. 3,000 w. 1 ill. 1 map. 1889. (In Engineering news, v.21, p.517.)
Describes the region, the construction of the South Fork dam on the Conemaugh river and the results of its failure.

Johnstown disaster. 2,000 w. 1889. (In Engineering news, v. 21, p.527.)
Editorial on causes and responsibility for the disaster.

Johnstown flood; effect on the engines at Conemaugh. 1,400 w. 1 diag. 1889. (In Engineering news, v.22, p.153.)

Describes and illustrates the position in which 32 locomotives were left by the flood. Some of them were carried almost a mile.

McLaurin, J. J.

Story of Johnstown; its early settlement, rise and progress, industrial growth and appalling flood on May 31st, 1889. 380 p. 19 ill. 1890.

Pennsylvania—Governor. (J. A. Beaver.)

Message to the General assembly, Jan. 6, 1891. 8 p. 1891.

Deals with Johnstown flood and work of the State board of health.
Appendix 11, p.1889. Contains preliminary report of the Secretary of the State board of health on the sanitary condition of the flooded regions in Cambria, Westmoreland, Indiana, Allegheny and Beaver counties.

Richards, J. W.

The flood at Johnstown. 400 w. 1889. (In Engineering news, v.22, p.40.)

Letter in which writer claims that the time in which the flood reached Johnstown was nearly an hour, instead of 20 minutes, as previously reported in "Engineering News."

Rivers at Johnstown, Pa. 1,000 w. 1891. (In Engineering news, v.25, p.614.)
Advance information from a report by J. J. R. Croes on flood dangers and preventive measures. Recommends widening and deepening of channel.

South Fork dam and Johnstown disaster. 3,200 w. 5 diag. 6 ill. 1889. (In Engineering news, v.21, p.540.)
Deals with location of dam, its structure and failure.
See also editorial, p.550.

South Fork dam. 3,200 w. 1889. (In Engineering news, v.21, p.551.)
Construction.

Work of the flood at Johnstown. 3,600 w. 7 ill. 1889. (In Engineering news, v.21, p.569.)

Mississippi

See also Bibliographies and indexes (Nelson and others.)—Levees.—Reservoirs.

Abbott, Frederic Vaughan.

Annual report upon construction of reservoirs at head waters of Mississippi river, improvement of Mississippi river from St. Paul to Minneapolis, of rivers in Wisconsin and Minnesota tributary to Mississippi river and of Red river of the North, gauging Mississippi river at St. Paul. 32 p. 1 map. 1 pl. 1898. (In United States—Engineer department. Report, 1898, pt.3, p.1809.)

Ballou, William Hosea.

Floods; their history and relations. 1,000 w. 1885. (In American naturalist, v.19, p.1159.)

Places cause of Mississippi floods in the Ohio valley.
"Congress will find it cheaper to purchase the land sources of the Ohio and its confluents, plant them with forests and wall them, than to plaster broken levees."

Bank protection on the Mississippi river. 1,300 w. 3 ill. 188[illegible]. (In Engineering news, v.22, p.558.)

Work at Greenville, Miss. Submerged dikes, formed from cribs of willows, wire and stone.

Bayley, G. W. R.

Overflow of the delta of the Mississippi. 7,000 w. 1852. (In De Bow's review of the Southern and Western states, v.13, n. s. v.1, p.166.)

Review of report by Charles Ellet, calling it "the best paper yet published [1852] upon the subject.

Bowman, Isaiah.

Deflection of the Mississippi. 2,200 w. 3 diag. 1904. (In Science, v.43, n. s. v.20, p.273.)

Study of effect of earth's rotation. Surveys and measurements in the flood-plain of the Vicksburg region.

Bridges, Lyman.

Overflow of the Mississippi river. 12,000 w. 1 ill. 1 folding map. 1882. (In Transactions of the American Society of Civil Engineers, v.11, p.251.)

With discussion.
Recommends relief channel or "cut-off" from Red river to Atchafalaya bay.

Brown, C. W.

Protection and drainage of lands subject to overflow. 3,100 w. 1910. (In Engineering record, v.61, p.254.)

Abstract of paper before Illinois Society of Engineers and Surveyors.

Special attention to drainage projects of large magnitude in the Mississippi valley. Run-off from high lands which naturally passes across the drainage area must be computed but should be diverted if possible. Diverting channels should be provided with settling basins of large area. Velocity during sedimentation should not exceed 0.3 to 0.4 foot per second. Author estimates for handling one-half of mean annual rainfall as seepage from the soil and other half as a mean monthly discharge. Levees should be carried 2 to 5 feet above highest recorded flood stage. Slopes are given for various materials. Cost of improvement must not exceed $20 to $30 per acre if landowners are to be induced to unite in the scheme.

Brown, Linus, W.

Increasing elevation of floods in the lower Mississippi river. 16 p. 1901. (In Journal of the Association of Engineering Societies, v.26, p.345.)

Discussion, 40 p.

The same, condensed. 4,000 w. (In Engineering news, v.45, p.280.)

From paper before Louisiana Engineering Society, March 11, 1901.

Author has had an acquaintance of 21 years with the Mississippi and its problems and has been for 15 years directly connected, officially and otherwise, with levee work on the lower river.

Arguments relative to increasing floods, cause and remedy, considering the river from Cairo to the Gulf. Elevation of great floods is increased not by reason of greater volume but by (1) construction of levees on lines not calculated to maintain a constant cross-section of the river; (2) changing of river-bed and moving back of levees around bends, thus increasing distance to ocean-level and decreasing slope; (3) formation of accretions on bottom and sides of channel at bends, without corresponding abrasion on concave side.

Considers levees absolutely necessary, but construction must be on more intelligent lines and aided by other equally important work, reservoirs, etc.

See also Hardee, for discussion.

Brown, Linus W.

Protection of cities in the Mississippi valley against the encroachment of the river. 3,000 w. 1901. (In Engineering news, v.45, p.427.)

Deals mainly with methods of shore protection.

Brown, Robert Marshall.

Protection of the alluvial basin of the Mississippi. 4,000 w. 3 diag. 2 maps, 1906. (In Popular science monthly, v.69, p.248.)

Compiled largely from reports of the Mississippi River Commission. Discusses necessity of protection, the levee system and its increasing efficiency.

Convention of the Interstate Mississippi River Improvement and Levee Association at New Orleans. 3,100 w. 1903. (In Engineering news, v.50, p.435.)

Convention Oct. 28, 1903. Resolutions reprinted from New Orleans "Picayune."

Claim that bed of Mississippi is not rising; condemn all "reservoir" and "outlet" schemes, considering the flood of 1903 a vindication of levee system. Recommend national control of Mississippi works.

Coppee, H. St. L.

Bank revetment on the Mississippi river. 18 p. 18 ill. 1896. (In Engineering magazine, v.11, p.486.)

Curtis, David A.

Mississippi river problem. 4,000 w. 1882. (In Harper's monthly magazine, v.65, p.608.)

Popular article on necessity of artificial protection from floods. Mentions proposed methods.

Dabney, A. L.

The high water fight. 400 w. 13 ill. 1897. (In Harper's weekly, v.41, pt.1, p.471, 472.)

Work during flood of March, 1897. Methods well illustrated.

Dabney, T. G.

The recent Mississippi river floods and their relation to the levees. 2,100 w. 1903. (In Engineering news, v.50, p.27.)

From manuscript report, on high water of 1903, to Mississippi River Commission.
Expresses confidence in levee system. Considers the most vulnerable feature to be the instability of the foundation in many places.

Dickson, Harris.

Fight for the levees. 1,800 w. 5 ill. 1903. (In Harper's weekly, v.47, pt.1, p.580.)

Graphic account of floods on lower Mississippi.

Dutton, Chauncey N. & **Coppee,** H. St. L.

More of the Mississippi problem. 5,000 w. 1892. (In Engineering magazine, v.3, p.623.)

Leading author considers levees indispensable; second author compares conditions with those on the Yellow river and the Po.

East St. Louis and the floods. 300 w. 1883. (In Engineering news, v.10, p.313.)

Advocates protection by raising the existing dyke and the railroad embankments.

Ellet, Charles, jr.

Of the physical geography of the Mississippi valley, with suggestions for the improvement of the navigation of the Ohio and other rivers. 26,000 w. 1849. (In Smithsonian Institution. Contributions to knowledge, v.2, art.4. [no.13].)

From ten years' daily gage readings at Wheeling, author concludes that by use of reservoirs a six-foot stage during entire year may be secured and that floods would be restrained.

Forshey, Caleb G.

Cut-offs on the Mississippi river; their effect on the channel above and below. 2,800 w. 1876. (In Transactions of the American Society of Civil Engineers, v.5, p.317.)

Retracts his former arguments in favor of Racourci "cut-off" and opposes all "cut-offs" as injurious.

Fullerton, Aubrey.

Completing of the Mississippi. 2,000 w. 4 ill. 1906. (In World to-day, v.10, p.494.)

Describes various improvements, including reservoirs, which, it is claimed, "prevent floods, except in their own immediate vicinity, and when they cannot fully prevent they reduce them."

Government protective works on the Mississippi river, at Plum Point and at Memphis, Tenn. 800 w. 4 ill. 1889. (In Engineering news, v.22, p.386.)

Illustrates bank revetment with willow mattresses, ballasted with stone.

Greenleaf, James L.

Hydrology of the Mississippi. 18 p. 3 diag. 1 map. 1896. (In American journal of science, v.152, ser.4, v.2, p.29.)

Graphic and tabular data on rainfall, flow and times of high and low water in Mississippi and tributaries.

Greenleaf, James L.

Times and causes of Western floods. 3,200 w. 1 map. 1897. (In Engineering magazine, v.12, p.949.)

Mississippi system. Rainfall and discharge data of principal watersheds, and chronological table of floods and low water for Mississippi tributaries are features.

Hardee, William Joseph.

Are flood heights increasing in the lower Mississippi river? 6,000 w. 1901. (In Engineering news, v.45, p.378.)

From paper before Louisiana Engineering Society, May 13, 1901, in discussion of paper by Brown. Claims that Mr. Brown's statements were based on insufficient data. Argues that carrying capacity of channel has not been reduced, that levee system is a success and will eventually prove the means of increasing carrying capacity of river, and that floods will pass at lower level than formerly.

Hardee, William Joseph.

High-water protection methods on lower Mississippi river. 9,000 w. 1900. (In Journal of the Association of Engineering Societies, v.25, p.85.)

Six separate agencies are now (1900) more or less active in levee construction. Author urges concentrated and systematic action. Believes that "a system for economically and efficiently preserving the levee line during flood can be devised."

Harris, L. O.

Battle for the delta. 2,000 w. 4 ill. 1903. (In Independent, v.55, pt.2, p.1135.)

Flood in spring of 1903 (?).
"Writer here presents not only an impressive and graphic study of the manner in which the population met the danger, but also outlines the trend of an already strong sentiment which is felt in three states and urgently demands consideration by the federal government." Editorial note.

Harrod, B. M.

Mississippi flood of 1890. 1,200 w. 3 diag. 1890. (In Engineering news, v.23, p.315.)

From New Orleans "Times-democrat." Author is a member of the Mississippi River Commission, and defends the levee-building policy of the commissioners, believing that the experience of the past eight years has been very encouraging.

Haupt, Herman.

Problem of the Mississippi. 3,800 w. 1899. (In Journal of the Franklin Institute, v.147, p.297.)

Considers reservoirs impracticable; objects to levees alone as tending to increase flood heights, and to outlets alone as diverting too much water during low stages. Favors a waste weir system, inoperative at ordinary levels, but allowing flood surplus to escape to Gulf by Atchafalaya and other streams.

Haupt, Lewis M.

Controlling the floods of the Mississippi river. 5,000 w. 3 ill. 3 maps. 1903. (In Journal of the Franklin Institute, v.156, p.241; v.157, p.387.)

Gives data from observation and experiment. Points out defects of levee system. Concludes that the problem requires: reservoirs on the tributaries, especially of the western sections; reforestation of arid regions; levees with readjusted alignment and weirs to be connected with large reservoirs in swamps; removal of bars and opening of all possible outlets at delta.
See also Meerten, for discussion.

Haupt, Lewis M.

Mississippi problem. 900 w. 1892. (In Engineering magazine, v.3, p.615.)

Discussion of paper by "Southern engineer."
Does not object to outlet plan, but favors levees also, and reservoirs on lower river.

Haupt, Lewis M.

Mississippi river problem. 25 p. 1 map. 1904. (In Proceedings of the American Philosophical Society, v.43, p.71.)

Comments on failure of the engineering profession to consider control of sediment as well as control of water. Instead of parallel jetties at river mouth "it will be found more rational to build one curved training wall so placed as to create a head and reaction which will transport the silt to the opposite or convex bank, where it will be deposited... leaving an ample navigable channel and saving the expense of one of the jetties, while it also scours away the bar...and affords an open passage for the effluent water."

Howard, D. S.

Overflow of the Mississippi river. 2,300 w. 1871-72. (In Journal of the Franklin Institute, v.92, ser.3, v.62, p.253; v.94, ser.3, v.64, p.334.)

Arguments in favor of reservoirs in contrast with levee system.

Johnson, J. B.

Great floods on the lower Mississippi, as illustrated in the flood of 1882. 3,200 w. 1 diag. 1 map. 1883. (In Journal of the Association of Engineering Societies, v.2, p.115.)

Sources of floods; general action of a large flood below Cairo; the flood of 1882.

Johnson, J. B.

Protection of the lower Mississippi valley from overflow. 7,000 w. 1884. (In Journal of the Association of Engineering Societies, v.3, p.169.)

The same, condensed. 5,500 w. 1890. (In Engineering news, v.23, p.364.)

Paper before Engineers' Club of St. Louis.
Discusses various systems, favoring levees high and strong enough to contain ordinary floods, with waste weirs through which the surplus waters of great floods may escape without damaging the levees.

Jones, W. A.

Annual report upon construction of reservoirs at head waters of Mississippi river, improvement of rivers in Wisconsin and Minnesota tributary to Mississippi river, and of Red river of the North, Minnesota and North Dakota; gauging Mississippi river at St. Paul. 39 p. 1897. (In United States —Engineer department. Report, 1897, pt.3, p.2137.)

Includes operation and care of reservoirs at head waters of Mississippi river, giving some figures of cost of construction and maintenance.
"The purpose of the reservoirs is to collect the surplus water...to be systematically released so as to benefit navigation upon the Mississippi...Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected."

Kellogg, D. O.

Mississippi floods. 1,500 w. 1883. (In The American [Philadelphia], v.6, p.297.)

Discussion of article by Shaler on "Floods of the Mississippi valley." Claims that breaking up and cultivation of prairie land acts as a valuable flood preventive by allowing rain to sink in ground. Thinks that with proper control of the Ohio, the flood problem of the Mississippi will be largely solved.

Leach, Smith S.

Mississippi problem. 3,000 w. 1888. (In Science, v.11, p.87.)

Discusses merits of revetment and anti-revetment theories of protection.

Lower Mississippi river. 2,000 w. 1 diag. 4 ill. 2 maps. 1899. (In United States—Geological survey. Annual report, v.20, pt.4, p.347.)

Discussion of levee system and the origin and control of floods.

Meerten, H. van.

Controlling the floods of the Mississippi. 3,500 w. 1904. (In Journal of the Franklin Institute, v.157, p.381; v.158, p.310.)

Letters discussing paper by Haupt on "Controlling the floods of the Mississippi river."

Agrees with many of the statements, but opposes plan of creating and maintaining outlets, and advocates application of principles successfully used in Holland. Commends the Eads system, which aimed at having "only one ample outlet for the great river, exactly as it is aimed by the Waterstaat for the Rhine and other great rivers." Commends also the Waterstaat idea of insisting on creation and maintenance of a distinct summer-, winter- and flood-bed. Thinks the same principles will apply to the Mississippi as to the Rhine; "the works only have to be undertaken upon relatively larger scale."

Meerten, H. van.

The Mississippi; controlling floods, navigation improvements. 6,500 w. 3 ill. 1905. (In Journal of the Franklin Institute, v.159, p.423.)

Final contribution to discussion of paper by Haupt.

Miller, A. M.

The Mississippi river improvements. 600 w. 1883. (In Engineering news, v.10, p.357.)

At Memphis reach and harbor and the Ouachita river, Ark. Mississippi flood record for a year is given.

Milner, B. C. Jr.

Floods along the Southern railway. 1,600 w. 4 ill. 1897. (In Railroad gazette, v.29, p.507.)

Mississippi flood. 1,600 w. 19 ill. 1897. (In Harper's weekly, v.41, pt.1, p.401.)

Flood of March, 1897. Statistics of damage by this and previous floods and cost of protective measures.

Mississippi floods. 600 w. 1883. (In Engineering news, v.10, p.313.)

"The present is the eighth great flood in the Mississippi of which we have authentic account."

Gives briefly the extent of each. Accepts the theory that the Mississippi is gradually filling up, and in course of time will find another channel.

Mississippi floods. 600 w. 1897. (In Public opinion, v.22, p.392.)

Newspaper editorials.

Mississippi river flood. 4 p. 1 map. April 22, 1897. (In United States—Department of agriculture. Miscellaneous circular no.3.)

Second report relative to extension of flood in lower Mississippi valley. First report appeared April 12, 1897.

Morrill, Park.

Floods of Mississippi river. 1897. 79 p. 3 ill. 51 maps. 9 pl. (In United States—Weather bureau. Bulletin E. [publication 143.])

The same. (In United States—Weather bureau. Report, 1896-97, p.369.)

New Orleans and Mississippi flood. 1,000 w. 1897. (In Scribner's magazine, v. 21, p.788.)

Editorial on flood and its proof of the inefficiency of present levee system. Criticizes unintelligent forest policy.

Ockerson, J. A.

Atchafalaya river; some of its peculiar physical characteristics. 3,500 w. 3 ill. 3 folding pl. 1906. (In Transactions of the American Society of Civil Engineers, v.58, p.1.)

A stream "widest at its source and deepest in places of excessive width." At high water serves as an outlet for about one-fourth of the flood volume of the Mississippi.

This paper presents, in a condensed form, the results of recent surveys, and brings to view features and characteristics of the stream that have heretofore received little notice. Considers levees and their effect.

Ockerson, J. A.

Improvement of the lower Mississippi river. 7,000 w. 3 ill. 1 map. 1901. (In Proceedings of the International Engineering Congress, Glasgow, sec.2, p.68.)

The same, abstract. 2,000 w. (In Engineering news, v.46, p.186.)

Discussion.

Outlines work of Mississippi River Commission, of which author is a member. Describes revetment and contraction work and the construction and maintenance of levees.

Parr, James F.

Floods and flood protection works at East St. Louis, Ill. 2,500 w. 2 maps. 1904. (In Engineering news, v.51, p.118, 179.)

Suggests several methods of protection; one a flood relief canal from the mouth of the Missouri river to the Mississippi 20 miles below East St. Louis. Favors, however, levee protection, with flood-gates at the outlets of creeks and pumping plants to be used during high water.
See also Taylor, W. D.

Pickett, William D.

Floods of the Mississippi delta; their causes, and suggestions as to their control. 20 p. 1909. (In Transactions of the American Society of Civil Engineers, v.63, p.53.)

Area of the delta is over 30,000 sq. mi., 65 per cent of which is "overflow" land. "There is no relief to be expected from the Ohio. It is left, then, to the Missouri watershed to furnish the means for the object required. The head waters of this stream must be impounded in immense reservoirs for such a length of time as will without doubt prevent the 'June rise' from making its advent until the 'spring rise' has passed."

Powell, John W.

Prevention of floods in the lower Mississippi. 2,500 w. 1888. (In Science, v.12, p.85.)

Probable effects of storage reservoirs.

Price, W. G.

Note on the improvement of the Mississippi river. 1,000 w. 1908. (In Transactions of the American Society of Civil Engineers, v.60, p.339.)

With discussion.
Remarks on bank revetment. "The writer believes that the power of flowing water in any silt and debris-bearing stream can be utilized and directed by a properly designed structure, so that it will dig a permanent foundation for such a structure."

Shaler, Nathaniel Southgate.

Floods of the Mississippi valley. 2,400 w. 1883. (In Atlantic monthly, v.51, p.653.)

Favors control by reservoirs and thinks that great relief would be afforded by "1,000 reservoirs averaging 50 acres in surface, with a mean depth of 10 feet."
See also Kellogg.

"Southern Engineer."

Geology and the Mississippi problem. 2,500 w. 4 diag. 1893. (In Engineering magazine, v.4, p.536.)

There is but one treatment for the Mississippi which will be at once scientific and sensible, and this will be found in giving it a channel as nearly straight as possible from Cairo to the Gulf."

"Southern Engineer."

Impending disaster on the Mississippi. 2,700 w. 1892. (In Engineering magazine, v.3, p.387.)

Discusses danger from the levee system and advocates cutting additional channels on the lower river.

Starling, William.

Floods of the Mississippi river. 900 w. 1894. (In Engineering news, v.31, p.318.)

Abstract from paper before Engineering congress in Chicago. Gives proportionate water-supply from the Missouri, the Ohio and the upper Mississippi valleys, and describes features of the usual Mississippi flood.

Starling, William.

Floods of the Mississippi river. 14,000 w. 4 diag. 4 ill. 3 maps. 1897. (In Engineering news, v.37, p.242, 259.)

By chief engineer Mississippi levee district, Greenville, Miss.

Starling, William.

Floods of the Mississippi river, including an account of their principal causes and effects and a description of the levee system and other means proposed and tried for the control of the river, with a particular account of the great flood of 1897. 57 p. 5 diag. 4 dr. 27 ill. 5 maps.

Reprint of three papers which appeared under various titles in "Engineering news," 1896–97.

Starling, William.

Improvement of the South pass of the Mississippi river. 8,200 w. 3 ill. 1 map. (In Engineering news, v.44, p.121.)

Considers the mouths of the river, effect of scour, attempts at dredging, and construction of jetties.

Starling, William.

Mississippi flood of 1897. 10,200 w. 8 ill. 1 map. 1897. (In Engineering news, v.38, p.2.)

Source of this flood was mainly the Ohio and its branches.
Considers the mouths of the river, effect of scour, attempts at dredging, and breaking and repairing of levees. Solutions discussed are storage reservoirs, shortening channel by "cut-offs," artificial outlets, and the levee system. Favors the last and criticizes the idea that confining a river by levees tends to raise the bed by deposition of silt.

Starling, William.

Mississippi problem up to date. 5,000 w. 3 diag. 1892. (In Engineering magazine, v.4, p.247.)

Schemes for improvement of Mississippi must recognize the fact that it is preëminently a silt-bearing stream. Discusses feasibility and probable effect of the various proposed methods.

Starling, William.

On flood heights in the Mississippi river, with special reference to the reach between Helena and Vicksburg. 17,000 w. 6 folding pl. 1889. (In Transactions of the American Society of Civil Engineers, v.20, p.195.)

Based largely upon measurements of Mississippi River Commission in 1882 and 1884–85.

Starling, William.

Projected improvement of the South-west pass. 12,000 w. 5 ill. 2 maps. 1900. (In Engineering news, v.44, p.222.)

Describes present (1900) condition of the pass, giving many typical cross-sections. Considers prevailing winds, shore currents, "mud lumps," wave action and other factors affecting the work. Describes the project for dredging and the proposed plans for mattress and jetty construction.

Stein, Albert.

Mississippi river and its levees, etc. 2,000 w. 1851. (In De Bow's review of the Southern and Western states, v.11, n. s. v.4, p.574.)

Criticism of committee report in favor of outlets, by S. Van Wickle, chairman, on behalf of the Senate of Louisiana, published in supplement of "New Orleans bee," April 13, 1850. Mr. Stein admits efficacy of outlets for flood prevention, but considers improvement of navigation the most urgent necessity, and to secure this he recommends abandonment of outlets and regulation of the passes to induce scour.

Taylor, Robert S.

How to improve the Mississippi. 10 p. 1884. (In North American review, v.138, p.284.)

Outlines plan of federal government for channel improvement and levee construction. Argues that artificial embankments necessary for channel improvement should be provided by national government, those for overflow protection by the communities interested.

Taylor, Robert S.

Subjugation of the Mississippi. 12 p. 1883. (In North American review, v.136, p.212.)

Organization and functions of the Mississippi River Commission, with discussion of the problems to be solved.

Taylor, W. D.

Relation of snow to the June rises of the Mississippi river. 900 w. 1904. (In Engineering news, v.51, p.179.)

Letter commenting on paper by Parr. Claims that melting snow has very little part in production of floods. Followed by editorial expressing a different opinion.

United States—Engineer corps.

Report by a special board of engineers on survey of Mississippi river from St. Louis, Mo., to its mouth, with a view to obtaining a channel 14 feet deep and of suitable width, including a consideration of the survey of a proposed waterway from Chicago, Ill., to St. Louis, Mo., heretofore reported upon. 2v. 1909.

v.1. Text. 532 p. with maps and diagrams.
v.2. Atlas. 52 large plates.

United States—Mississippi river commission.

Reports, 1881-83. 3v. ill. 1882-84.

The same, 1880-date. (In United States—Engineer department. Annual report of the chief of engineers, 1881-date.)

Report of 1880 is a preliminary report. Two reports were issued in 1881, in January and November. Supplemental reports were issued in 1885–88.
Chiefly concerned with engineering operations, but considers floods of the Mississippi and some of its tributaries.

Walker, Norman.

Mississippi floods. 2,000 w. 13 ill. 1897. (In Harper's weekly, v.41, pt.1, p.405, 408, 422.)

Presents importance of the Mississippi problem, urging definite action. Describes present (1897) conditions.

Winslow—Eveleth E.

Résumé of the operations in the first and second districts, Mississippi river improvement, 1882-1901, with supplement containing plates 1 to 73. 296 p. 13 ill. 1910. (In United States—Engineer school. Occasional papers, no.41.)

First district extends from Cairo to the foot of Island 40, a distance of about 220 miles. Second district extends from the foot of Island 40 to the mouth of White river, a distance of about 175 miles.
Describes in detail contraction works and bank revetment and arrives at the following conclusions: "That the banks of the river can be successfully revetted; that side chutes can be successfully closed and that the river can be otherwise contracted where necessary; that these works both of revetment and contraction will be expensive; that an efficient and

permanent regulation is not possible except by bank revetment, but that contraction will also be necessary in places; that...in general the full results of work of either class will not be shown for several seasons; that the permanency of location will be more easily obtained the greater the curvature of the bends and the more regular the curvature; that in systematic regulation the work should start at the head of a reach and should proceed regularly downstream and that in general the complete regulation of the river will be a work of vast magnitude that would at best extend over a long series of years."

Missouri and Branches

Byers, Charles Alma.

Kansas river flood. 1,800 w. 1904. (In Scientific American supplement, v.57, p.23502.)

"An examination has shown that more than 90 per cent of the damage done to farm lands was directly connected with sharp curves in the river channel." Recent flood tended to straighten course by forming new channels.

Devine, Edward T.

Two disasters and the work of relief. 1,800 w. 4 ill. 1903. (In Charities, v.11, p.9.)

Kansas City and Heppner.

Fox, S. Waters.

Technical methods of river improvement as developed on the lower Missouri river by the general government from 1876 to 1903. 46 p. 19 ill. 3 folding pl. 1905. (In Transactions of the American Society of Civil Engineers, v.54, pt.7, p.280.)

Discussion, 20 p. 9 ill.
Valuable paper, chiefly on methods of bank protection. Considers briefly the usual April and June floods.

Kansas City flood in retrospect. 900 w. 1903. (In Charities, v.11, p.574.)
Emergency relief work, June, 1903.

Struggle of the Chicago & Alton against the encroachments of the Missouri river. 2,000 w. 4 ill. 1 map. 1907. (In Railway age, v.43, p.112.)

From notes furnished by office of chief engineer, Chicago & Alton railroad. Dike construction is favored rather than revetment.

Waddell, J. A. L.

Kansas City flow-line bridge repairs. 5,400 w. 6 ill. 1903. (In Engineering news, v.50, p.397.)
The same, with introductory notes. 1905. (In Principal professional papers of Dr. J. A. L. Waddell; ed. by Harrington, p.915.)

Gives also some details of the flood of May 31, 1903.

Waddell, J. A. L. & **Hedrick.**

Engineering aspects of the Kansas floods. 2,500 w. 3 ill. 1 map. 1903. (In Engineering record, v.48, p.300.)

Location and brief description of the 17 bridges destroyed.

Waddell, J. A. L. & **Hedrick.**

Kansas City flood of 1903. 2,300 w. 8 ill. 1 map. 1903. (In Engineering news, v.50, p.233.)

Statement of the results of the flood and the main features of engineering interest in connection therewith. The city water-main was carried on one of the bridges of which a span of 185 feet was demolished. As a result the city was for 12 days without water, street-car service, gas lights and electric lights.

Willey, Day Allen.

Protecting a railroad from flood currents. 1,200 w. 6 ill. 1902. (In Scientific American, v.101, n. s. v.87, p.361.)

Ballasted mattress revetment for protection of Chicago & Alton tracks along banks of the Missouri river. Permanent protection at low cost.

Ohio and Branches

See also Flood Prediction (Mahan & Lemoine).

Allegheny river. 500 w. 1899. (In United States—Geological survey. Water-supply and irrigation papers, no.36, p.158.)

Data on watershed and tributaries, flood heights, etc., by George M. Lehman and others.

Brunot, Felix R.

Improvement of the Ohio river. 23 p. 9 dr. 1874. (In Journal of the Franklin Institute, v.97, ser.3, v.67, p.305.)

The same, separate.

Agrees with Mr. W. Milnor Roberts that in any system of river improvement reservoirs may be useful adjuncts, but thinks that in the case of the Ohio the scheme is impracticable by reason of the lack of sites, size of stream, extraordinary floods, and rapid flow of tributaries. Largely a discussion of report by United States engineers G. Weitzel and W. E. Merrill. This report describes 13 proposed methods for improving navigation.

Connor, William D.

Application of the reservoir system to the improvement of the Ohio river. 6,300 w. 1908. (In Engineering news, v.59, p.621.)

"References," p.624.
Criticism of reservoir project, with special reference to paper of Leighton, p.498. Considers fully the disadvantages under cost, danger, time of completion, and durability. Concludes that the reservoir system "is impracticable from even a moderately conservative point of view for flood protection. It is a physical impossibility for it to produce the constant 9-ft. channel required in the Ohio, and the figures on the income from its water power are...extravagant in the extreme."

Difficulty of preventing the Ohio floods. 1,200 w. 1884. (In Science, v.3, p.385.)

From letter by William E. Merrill in "Cincinnati commercial gazette."
Disapproves of reservoirs on account of expense and danger. Foresees no injury from the clearing of level land but admits the probability of disastrous effects from the deforestation and cultivation of hill and mountain sides. Tries to discourage efforts at flood prevention and advocates flood-proof construction of buildings in flood-threatened regions.

Easton, Christopher.

Flood in Pittsburgh. 1,200 w. 1907. (In Charities and the Commons, v.17, p.1115.)

Flood of March, 1907.
Losses, and measures for relief and sanitation.

Haupt, Herman.

Consideration of the plans proposed for the improvement of the Ohio river. 54 p. 1855.

Discusses scheme of Ellet for reservoir system, recognizing its merits but considering a slackwater scheme more sure and efficient.

Horton, A. H.

Effect of the conservation of flow in the Ohio basin on floods in the lower Mississippi. 3,600 w. 1908. (In Engineering news, v.59, p.631.)

Points out that floods in the lower Mississippi originate chiefly in the Ohio, and concludes that "with the Ohio controlled by a reservoir system, the floods of the lower Mississippi would be reduced to such stages as would cause little or no apprehension."

Lehman, George M.

Examination of Youghiogheny river between West Newton and...McKeesport. 1,800 w. 1899. (In United States—Engineer department. Report, 1900, pt.5, p.3288.)

Survey to obtain information bearing on slackwater project. Includes physical, geological and hydrographic features; height of greatest flood. Data given as to area and amount of coal remaining, adjacent to river. Mentions early locks and dams on the Youghiogheny.

Lehman, George M.

Survey of Allegheny river from Oil City to Tarentum, Pa. 28 p. 2 pl. 1898. (In United States—55th congress, 3d session. House document no.72, p.10.)

In report of Maj. Charles F. Powell. Survey to obtain information bearing on slackwater project. Includes a description of the physical, geological and hydrographic features, height of greatest flood, etc. Feasibility of a canal between the Allegheny and Lake Erie.

Lehman, George M.

Survey of West Fork river, West Virginia. 11 p. 1899. (In United States—Engineer department. Report, 1900, pt.5, p.3272.)

Survey to obtain information bearing on slackwater project. Includes physical, geological and hydrographic features, flood data, etc. Suggests a storage reservoir as only means of adequate supply for proposed navigation project.

Leighton, Marshall Ora.

Application of the reservoir system to the improvement of the Ohio river. 2,800 w. 1908. (In Engineering news, v.59, p.624.)

Reply to criticism by Connor, p.621.

Leighton, Marshall Ora.

Relation of water conservation to flood prevention and navigation in the Ohio river. 14,000 w. 1 map. 1908. (In Engineering news, v.59, p.498, 511.)

Appendix to preliminary report of Inland Waterways commission.
Valuable paper, also editorial. Proposes to provide reservoir capacity sufficient "to store the top wave of the flood, which does nearly all the damage." Gives history of reservoir regulation; reservoir possibilities on Allegheny, Monongahela, Kanawha and Tennessee; influence of reservoirs on flood heights at Pittsburgh, Cincinnati and other points; effects on navigation; cost of reservoir system and benefits which would result. Contemplates about 100 reservoirs. Cost estimates unusually low.

Lessons of the Shawneetown flood. 800 w. 1898. (In Public opinion, v.24, p.456.)

Editorials on disastrous flood at Shawneetown, Ill., from "Chicago times-herald," "Chicago record," "St Louis globe-democrat," and "Pittsburgh commercial-gazette."

McElroy, Samuel.

Ohio floods. 1,200 w. 1884. (In Engineering news, v.11, p.163.)

Advocates reservoir construction on tributaries of the Allegheny and Monongahela and attempts to show feasibility of such a course.

Merrill, William E.

Improvement of the Ohio river. 139 p. 5 folding pl. 1879. (In United States—Engineer department. Report, 1879, pt.2, p.1299.)

"Statement of the work done on this river from July 1, 1878, to June 30, 1879. The localities are named in the order of natural succession beginning at Pittsburgh."
With reports and surveys of branches, including Muskingum and Allegheny by Thomas P. Roberts, and Kiskiminetas and Conemaugh by James Worrall.

Merrill, William E.

Ohio river floods. 1,700 w. 1884. (In Engineering news, v.11, p.137.)

Special reference to conditions in Cincinnati. Considers control by artificial reservoirs impracticable. Protests against the practice in large cities, of encroaching on the river's banks. Does not favor a levee, but advocates the use of lowlands for business purposes only, and the construction of all buildings with a view to possible floods.

Morris, Ellwood.

On the improvement of the Ohio river. 24 p. 3 dr. 2 folding pl. 1857. (In Journal of the Franklin Institute, v.63, ser.3, v.33, p.1, 145.; v.65, ser.3, v.35, p.1.)

Claims "that by using six large artificial lakes, to be filled and emptied but once a year, a navigable depth of six feet can be permanently maintained by an outlay in reservoirs of $12,000,000...That six artificial lakes of the size herein contemplated, could not fail to exert a material influence in moderating the Ohio river floods."
The third article is a review of papers by Roberts.

Newcomer, H. C.

Proposed reservoir system in Ohio river basin. 1908. (In Engineering News, v.60, p.376.)
Criticism of paper by M. O. Leighton. This paper is abstracted in App. No. 6.

Ohio and Mississippi floods. 900 w. 1 ill. 1903. (In American monthly review of reviews, v.27, p.606.)

Pittsburgh—Flood commission.

Flood commission of Pittsburgh, organized to investigate and find means for protection against floods. 8 p. [1909.]

Pamphlet explaining object of the commission, summarizing extent of floods and presenting preliminary recommendations.

Powell, John W.

Our recent floods. 11 p. 1892. (In North American review, v.155, p.149.)

By director of United States geological survey.
Very general treatment of flood causes and prevention. The only flood specifically mentioned is the Allegheny "oil flood" of 1865 (?).

Powell, S. W.

Drowning the torrent in vegetation. 3,300 w. 1884. (In Popular science monthly, v.26, p.67.)

"The extraordinarily disastrous floods of 1883–84, in the Ohio river, have again called public attention to the close relation which the wooded or unwooded condition of steep hill-sides in the area drained by streams, bears to the volume of water flowing in them."
Presents desirability of a great forest reservation in the Adirondacks.

Reservoir system for control of the Ohio river. 2,800 w. 1908. (In Engineering news, v.59, p.638.)

Editorial comment on recent papers of Leighton, Connor and Horton, all printed in "Engineering news" (v.59, p.498, 621, 624, 631). Recognizes the value of reservoirs but calls attention to the necessity also of levees on the Mississippi, and to the advantages of forest preservation as a check on soil erosion and filling of reservoirs by silt.

Roberts, Thomas Paschall.

Floods and means of their prevention in our western rivers. 5,000 w. 1 map. 1907. (In Proceedings of the Engineers' Society of Western Pennsylvania, v.23, p.306, 365.)

Discussion, 20,000 w. 1 diag.
Various plans for protection of Pittsburgh. Recommends raising of streets and buildings in flood section; construction of a concrete wall from 10 to 12 feet below surface of ground to flood level; pumping plants for emptying sewers at flood times. The effect of forests, and various other topics are discussed by well-known local engineers.

Roberts, Thomas Paschall.

Monongahela river; some of its characteristics and brief sketch of methods undertaken for the improvement of its navigation. 6,000 w. 2 dr. 1908. (In Proceedings of the Engineers' Society of Western Pennsylvania, v.24, p.194.)

Discussion, 2,000 w.
Considers floods.

Roberts, W. Milnor.

Practical views on the proposed improvement of the Ohio river. 78 p. 1857-58. (In Journal of the Franklin Institute, v.64, ser.3, v.34, p.23, 73, 145, 217, 289, 354, 361; v.65, ser.3, v.35, p.73.)

Rather brief consideration of floods, in final remarks and elsewhere. Two of the later articles are in reply to Ellet. (See reference under Mississippi.)

Shawneetown levee disaster. 800 w. 1898. (In Engineering record, v.37, p.446.)

Editorial on flood of April 3, 1898. When crevasse occurred flood was three feet below crest of levee. Two possible causes of the break are suggested: the burrowing of muskrats, and imperfect construction around a drain-pipe passing through levee.

United States—Engineer corps

Ohio river; letter from the secretary of war transmitting, with a letter from the chief of engineers, report of a board of engineers on an examination of the Ohio river with a view to obtaining channel depths of 6 and 9 feet respectively. ill. 1908. (60th cong. 1st sess. House Doc. v.17.)

Numerous maps and diagrams, including 29 folding plates.

Wines, Frederick Howard.

Flood at Shawneetown. 1,800 w. 1898. (In Charities review, v.8, p.175.)

Ohio river crevasse and its disastrous effects at Shawneetown, Ill.

Passaic

See also Bibliographies and Indexes (Hollister & Leighton)

Flood damage to bridges at Paterson, N. J. 1,500 w. 8 ill. 1903. (In Engineering news, v.50, p.377.)

Passaic river flood of October, 1903. Two concrete bridges wrecked.
See also p.352.

Floods in the Passaic valley. 1,000 w. 1903. (In Engineering record, v.48, p.449.)

Editorial on the frequent destructive floods in this region. Their annual repetition can be prevented only by expensive protection works, which, it is suggested, should be taken in charge by the state of New Jersey.

Report of the Passaic River Flood District Commission. 79 p. 16 ill. 17 folding pl. 1906. [published 1907.]

Favors erection of controlling works at Mountain View, involving the flooding of Pompton basin.
Includes report of engineer with cost estimates, and such suggestions for legislation as have met with the approval of the commission.

Sherrerd, Morris R.

Flood control and conservation of water applied to Passaic river. 2,400 w. 1906. (In Engineering record, v.54, p.605.)

The same, condensed. 1,300 w. 1907. (In Engineering magazine, v.32, p.790.)

Paper before New Jersey Sanitary Association.
Conservancy both for power and water-supply purposes. Investigation prompted by the necessity for flood control. Favors state expenditure of $11,000,000 to accomplish flood control and conservation of 200,000,000 gallons of potable water per day, which would at present (1906) be furnished partly to New York city, but eventually marketed entirely among New Jersey cities.

Susquehanna

Hoyt, John C. & **Anderson,** Robert H.

Notes on the flood of March, 1904, in the lower Susquehanna river. 1,000 w. 3 ill. 1904. (In Engineering news, v.51, p.393.)

Effect at various points. Comparison with other floods to determine points most frequently subject to ice gorges.

Raymond, Charles W.

Preliminary examination of the west branch of the Susquehanna river...with a view of ascertaining the best practicable method of confining the waters of said river, in times of great flood, to the general course of its channel. 4,500 w. 1890. (In United States—Engineer department. Annual report, 1891, pt.2, p.1102.)

The same, abstract. 2,000 w. (In Engineering record, v.25, p.128.)

The same, abstract. 1,800 w. (In Engineering news, v.25, p.152.)

Suggested means of prevention are forest preservation, storage reservoirs, and transverse barriers across lines of drainage to aid in checking flood volumes. Means of control are levees, increase of channel dimensions, removal of causes of temporary obstruction.

Raymond, Charles W. & **Schermerhorn,** L. Y.

Proposed flood protection for Williamsport, Pa. 700 w. 1895. (In Engineering news, v.34, p.309.)

Abstract of United States engineers' report. Recommends removal of present dam and substitution of movable one to be lowered during floods; rectification of river section at each of three bridges; dikes for all lower parts of city; rectification of mouth of Lycoming creek; removal of islands and boom piers within city limits; an improved sewerage system, and a pumping plant for drainage of low districts at flood times.

Waters, O. P.

Flood damage to the York Haven power plant. 700 w. 2 ill. 1904. (In Engineering record, v.49, p.361.)

Hydroelectric plant on the Susquehanna river, erected at a cost of $1,500,000, damaged by the worst ice freshet in 110 years.

MISCELLANEOUS

Eastern United States.

Bixby, Gen. William H.

River and harbor improvements under the corps of engineers, United States army. 10,000 w. 1910.

Pamphlet. Reprint of address delivered before National Rivers and Harbors Congress, held at Washington, D. C., Dec. 8, 1910. Speaks of limitations imposed on Engineer department and the necessity hitherto of restricting the work to navigation interests. Recognizes importance of bank protection, levee construction and reclamation and calls attention to the fact that present and future investigations are to include consideration of water-power developments wherever cost of navigation improvement may be lessened thereby.

Allen, Charles Julius.

Annual report upon improvement of Potomac river and its tributaries, of James river and harbor at Milford Haven, and rivers in Virginia on western shore of Chesapeake bay, protection of Jamestown island. 58 p. 1 map. 1899. (In United States—Engineer department. Report, 1899, pt.2, p.1413.)

The same. 60 p. 5 maps. 1900. (In same, 1900, pt.2, p.1701.)

Ayres, Philip W.

Commercial importance of the White mountain forests. 32 p. 1909. (United States—Forestry bureau. Circular 168.)

Discusses at some length the influence on water-power and on navigation, claiming that forest removal increases floods and that for securing uniformity of stream-flow "forest preservation over wide areas, and especially on steep slopes is the only sure dependence."

Fitzgerald, Desmond.

Yield of the Sudbury river watershed in the freshet of Feb. 10th-13th, 1886. 3,000 w. 1 folding pl. 1891. (In Transactions of the American Society of Civil Engineers, v.25, p.253.)

This watershed is one of the sources of water-supply of the city of Boston.

Flood protection in Ithaca, N. Y. 2,000 w. 5 dr. 1 ill. 1 map. 1907. (In Engineering record, v.55, p.684.)

Describes conditions at Cayuga lake and the work of confining Six Mile run to a safe channel.

Francis, James B.

Distribution of rain-fall during the great storm of October 3 and 4, 1869. 2,000 w. 1 folding map. 7 p. of tables. (In Transactions of the American Society of Civil Engineers, v.7, p.224.)

Data on a very heavy rain in eastern United States which caused great floods. During this storm the rainfall at Canton, Conn., was 12.35 inches.

Hartford, Conn.

Report of the joint special committee of the court of common council on East side flood protection, and that of city engineer Frederick L. Ford upon (1) a general plan for the abatement of the nuisance caused by freshets in the Connecticut river; (2) the improvement of sewerage facilities in the Colt meadow district; (3) the future disposal of sewage from the Franklin avenue sewerage district; submitted to the court of common council on Oct. 12, 1908, Feb. 23 and March 8, 1909. 89 p. 10 ill. 12 folding pl. 1909.

Two methods are applicable: "(1) Completion of the dyking around the unprotected area. (2) Raising of the entire inundated district." The former scheme is favored in the present report, as has been the case also in previous reports of engineers and committees, extending over almost half a century. Former reports have disagreed as to location and height of proposed dike. Present committee looks with disfavor on the scheme for raising the flooded area, on account of the expense and the difficulty of securing coöperation of the property owners. Report includes careful study of rainfall and stream measurement and gives estimates of cost.

Knowles, Morris, & **Lehman,** George M.

Forest reserves in Appalachian mountains; report of special committee attending hearing before House committee on agriculture to the Chamber of Commerce of Pittsburgh. 8 p. 1908.

Has reference to bill "For acquiring national forests in the southern Appalachian and White mountains." Authors of this report submitted evidence showing increasing tendency to flooding of the Pittsburgh region, and in their conclusion strongly recommended support of the bill.

Myers, E. W.

Study of the Southern river floods of May and June, 1901. 3,600 w. 6 ill. 1902. (In Engineering news, v.48, p.102.)

Causes and effects of floods in North Carolina and West Virginia.

Pennsylvania—Water supply commission.

Report. 1905-1908.

1907. Water companies.—Obstructions to streams.—Hydrographic features of Pennsylvania.—Deforestation and its effects on stream flow.—Floods.—Water power.—1908: Inactive water companies.—Obstructions to streams.—Methods of bank protection.—Rainfall.—Drought.—Floods during 1908.—Report of the engineer of the commission upon the causes and methods of relief from floods in Turtle creek, Westmoreland and Allegheny counties.

Report of the New York Water Storage Commission. 1,400 w. 1903. (In Engineering news, v.49, p.115, 183.)

Abstract. Commission was appointed in April, 1902, to investigate floods and their prevention. Recommends state supervision and control, entrusting the execution of the work to a permanent commission. Favors in general water storage and channel regulation.

Riegel, R. M.

Paxton creek flood controlling works, Harrisburg, Pa. 3,800 w. 4 dr. 3 ill. 1910. (In Engineering news, v.63, p.196.)

From "Cornell civil engineer," Oct., 1909.
Stream with drainage area of about 23 sq. mi. Control work begun May, 1908; finished Jan., 1909. Two floods have since occurred without causing trouble. Scheme provides protection by diversion to Susquehanna river through large flood channel, with additional provision of a reservoir with storage capacity sufficient to carry the peak of the maximum flood expected. Construction costs are given.

System of protection of Corning, N. Y. from floods in the Chemung river. 2,500 w. 9 ill. 1897. (In Engineering news, v.38, p.146.)

Main feature is a low, sod-covered earth dike, eight feet wide on top with slopes of three to one on the river and two to one on the land side. Seven small streams flow into the river; most of these are led through the dike in closed conduits with flap valve at end.

West Virginia flood. 500 w. 4 ill. 1901. (In Scientific American, v.85, p.43.)

Devastation in Elkhorn valley and Pocahontas coal region, June 22–23, 1901.

Zook, M. A.

Flood repairs to the Lehigh & Susquehanna division of the Central Railroad of New Jersey. 1,000 w. 3 ill. 1904. (In Engineering news, v.51, p.97.)

Floods in Lehigh valley Dec. 15, 1901, and Feb. 28, 1902, damaged road-bed in many places and wrecked a number of bridges, notably at East Allentown and Easton. Pa.

Western United States.

Burton, J. R.

Flood prevention and irrigation; twin ideas. 11 p. 1903. (In North American review, v.177, p.522.)

By United States senator from Kansas (1901–07), considering particularly that section.

Can floods be prevented? 400 w. 1903. (In Independent, v.55, pt.2, p.1474.)

Editorial on conditions in western United States, favoring dams in ravines, forest protection, and especially the immediate establishment of a permanent reservoir system under government control.

Clapp, W. B. and others.

Flood of March, 1907, in the Sacramento and San Joaquin river basins, California. 50 p. 1 diag. 2 maps. 1908. (In Transactions of the American Society of Civil Engineers, v.34, p.99.)

Discussion, 31 p., p.367, 460.
The flood problem of the Sacramento valley is a serious one. The authors, and many of those taking part in the discussion favor storage reservoirs.

Damage by the March floods on the P. C. C. & St. L. 1,100 w. 4 ill. 1897. (In Railroad gazette, v.29, p.336.)

Serious damage to track and to many bridges by sudden rise of Miami and other rivers.

Flood at Guthrie, Oklahoma. 1,100 w. 1897. (In Harper's weekly, v.41, pt.1, p.499, 500.)

Sudden and destructive flood on Cottonwood river.

Flood protection along Cherry creek in Denver, Colo. 1,400 w. 3 dr. 1908. (In Engineering record, v.57, p.175.)

Tributary of South Platte river. Fall about 30 ft. per mile.
Describes two continuous reinforced concrete retaining walls erected to form a new channel, with a uniform width of 80 ft. and a minimum depth of 8 ft.

Flood protection in Grand Rapids, Mich. 5,400 w. 2 dr. 3 ill. 1908. (In Engineering record, v.58, p.495.)

Project includes extensive channel and shore improvement and will create a valuable water-power. Involves expenditure of $1,000,000 for flood protection with $500,000 additional for sewers.

Foote, A. D.

Redemption of the great valley of California. 18 p. 1 map. 2 dr. 1910. (In Transactions of the American Society of Civil Engineers, v.66, p.229.)

Discussion, 35 p.

The same, abstract. 4,000 w. 1 map. (In Engineering news, v.62, p.647.)

Scheme combining flood prevention and land fertilization by basin irrigation. Includes Sacramento, San Joaquin, Tulare and Kern valleys, and the bordering foot-hills. Proposes dividing up entire alluvial area of the valleys into

basins (10 to 20 miles long and 1 to 3 miles wide) by means of dykes parallel to the general land contours. During high water these basins are to be filled to a depth of several feet, thus affording a large storage capacity, securing irrigation and deposition of silt. Drainage is to be effected by channels paralleling the river on either side. Channel openings to be controlled by gates, more complete water distribution secured by movable dams, and inflow of mining waste prevented by debris barriers at intervals along the mountain streams.

"Flood capacity of the river and escape channels would be somewhat more than 100,000 cu. ft. per sec. more than was ever required in the valley...It will take a number of years to complete the scheme and may require $75,000,000."

Galveston flood. 600 w. 1900. (In Engineering news, v.44, p.196.)

Considers rebuilding of city and suggests grade raising.

Going, Charles B.

Causes of floods in Western rivers. 1,800 w. 11 ill. 1895. (In Engineering magazine, v.8, p.1038.)

Compares rivers of Atlantic seaboard with those west of Appalachian mountains.

Going, Charles B.

Effects of floods in Western rivers. 4,000 w. 1892. (In Engineering magazine, v.3, p.795.)

Contrast with rivers of eastern United States.

Harger, Charles Moreau.

Recent floods of the middle West. 1,200 w. 8 ill. 1903. (In American monthly review of reviews, v.28, p.74.)

Johnston, Thomas T.

The great waterway to connect Lake Michigan with the Mississippi river and its influence on floods in the Illinois river. 3,500 w. 10 diag. 1887. (In Journal of the Association of Engineering Societies, v.6, p.182.)

Discussion by James A. Seddon. 1,200 w.

Kenyon, W. J.

Story of the Sacramento flood. 2,000 w. 3 ill. 1907. (In World to-day, v.12, p.632.)

Flood in spring of 1907 in double valley of Sacramento and San Joaquin rivers. Popular account, mainly of rescues. Gives proposed schemes to prevent future floods.

Land reclamation along the Illinois river. 1,500 w. 1 ill. 1 map. 1905. (In Engineering record, v.52, p.150.)

Methods for flood protection of about 80,000 acres of land several feet below high-water level. Levees, built by boom and bucket dredge, have withstood several floods.

Noble, Alfred, and others.

Plans for the protection of Galveston from floods. 2,200 w. 1 dr. 1 map. 1902. (In Engineering news, v.47, p.344.)

Abstract of committee report. Recommends a concrete sea-wall more than three miles long. It is also proposed to raise level of city eight to twelve feet.

Olesen, J. Y.

Flood protection in the Kansas river valley at Kansas City. 3,000 w. 3 diag. 1 map. 1909. (In Engineering news, v.62, p.82.)

Watershed is 60,000 sq. mi., and channel at mouth can carry only 0.1 in. run-off per day from this area or 150,000 cu. ft. per sec. without danger of overflow. A drainage district has been established and will follow substantially the protective measures recommended by a board of army engineers in 1904, as follows: (1) Banks for a distance of 17,000 ft. above mouth to be protected by solid concrete walls, 30 ft. high above mean low water, resting on piles driven to bed rock; (2) Width between top of walls, 734 ft.; (3) River bed to be dredged free of all solid obstructions, 15 ft. below low water, thus allowing silt to be carried out by scour at high velocity of flood water; (4) All bridges limited to two piers 300 ft. c. to c.; (5) Above the 17,000 ft. limit earth embankments protected by riprap; (6) Levee and bank revetment along right bank of the Missouri.

Report of the commission of engineers on the rectification of the Sacramento and San Joaquin rivers. 7,500 w. 1 map. 1905. (In Engineering news, v.53, p.250.)

Expert report to the River Improvement and Drainage Association of California. Includes discussion of rejected propositions and outlines plan proposed by present commission. Gives estimates. About 1,700 square miles will be protected from floods.

Robinson, A. F.

Floods on the Santa Fe system. 600 w. 7 ill. 1904. (In Railway age, v.38, p.850.)

Some remarkable results. Illustrates a masonry abutment weighing more than 600 tons which was carried 150 feet down stream without upsetting or cracking the masonry.

Robinson, H. F.

Report of the flood on the Zuni river, Sept. 6, 1909. 1,000 w. 1 map. 1 table. 1910. (In Engineering news, v.64, p.203.)

Partial failure of Zuni dam, through undermining by passage of water beneath a lava cap which extended under spillway. Resulted in settling of from 4 to 9 feet and leakage of 5,000 cu. ft. per sec. Drainage area above dam is 650 sq. mi. at elevations varying from 6,300 ft. at reservoir to 9,200 ft. on mountain tops.

Stevens, John C.

Water powers of the Cascade range; pt.1, southern Washington. 94 p. 3 diag. 21 pl. 1910. (United States geological survey. Water supply paper 253.)

Considers at some length the variations in stream flow and more briefly conditions affecting stream flow, and floods.

United States—Engineer corps.

Sacramento river, California; reports of examination and survey of Sacramento river, California, from its mouth to Feather river. 19 p. 1908. (60th cong. 2d sess. House Doc. v.24.)

Brief report with 26 maps. Includes estimates of cost of improvements.

United States—Engineer corps.

San Joaquin river, Stockton channel, etc., from San Francisco bay to Stockton, Cal.; reports of examination and survey. 18 p. 1908. (60th cong. 2d sess. House Doc. v.25.)

Brief report with 17 maps. Includes estimates of cost of projects for improvement of navigation.

Whistler, John T.

The Heppner disaster. 1,800 w. 1903. (In Engineering news, v.50, p.53.)

From report to United States geological survey.
Sudden flood of June 14, 1903, at Heppner, Oregon, on Willow creek. In author's opinion "the great destructiveness of these so-called 'cloud-bursts' is due more to the rugged character of the topography, and the almost utter absence of vegetation, than to the unusual rainfall."

Other Rivers

Breithaupt, W. H.

Grand river, Ontario peninsula; effect of deforestation and swamp drainage. 2,000 w. 1 diag. 2 ill. 1 map. 1905. (In Transactions of the Canadian Society of Civil Engineers, v.19, p.302.)

Discussion, 400 w.
"It is clear that precipitation in the peninsula is not materially affected by deforestation...The run-off is, however, very directly affected....The flow regulation of the river by means of large storage basins is for the present hardly practicable from an economical view point, and will not here be further considered."
Favors reforestation and leaving of swamps and marshes undrained.

Campbell, R. E.

Forests of Canada in relation to the water supply. 10 p. 1909. (In Official proceedings of the National Irrigation Congress, v.17, p.102.)

Deals with a district in which the rivers and streams are subject to sudden floods, often disastrous. As a move towards control of flood waters an examination is [1909] being made of possible reservoir sites on some of the main streams. Claims that forests "have a...beneficial regulative effect on the stream flow."

Conway, G. R. G.

Recent floods at Monterey, N. L., Mexico. 2,200 w. 1 diag. 1 dr. 5 ill. 2 maps. 1909. (In Engineering news, v.62, p.315.)

Description of a disastrous flood with records of rainfall and run-off.

Crowell, J. Foster.

Characteristics of the Ravine du Sud in the island of Hayti, and plan for averting its overflow. 10,800 w. 1 ill. 3 folding pl. 1891. (In Transactions of the American Society of Civil Engineers, v.24, p.470.)

Discussion, 2,500 w. 1 diag. (In same, v.25, p. 343.)
"The word ravine is here to be taken in its French significance, implying a raging torrent, and not merely as a term of topographical configuration." Recommends an artificial channel to lead flood waters to sea.

Garriott, E. B.

Storms, floods and cold waves of the year [1897]. 2,800 w. 1898. (In United States—Weather bureau. Report, 1898, p.27.)

The same. (In United States—Department of agriculture. Annual report, 1898, p.208.)

Gives brief information on the most important floods of the year in the United States.

Lewis, Samuel J.

The Monterey flood and San Luisito bridge. 1,800 w. 4 ill. 1 map. 1909. (In Mining and scientific press, v.99, p.494.)

Flood in Santa Catarina river, Aug. 27, 1909. Drainage area is 2,000,000 acres, probably less than 10 per cent being covered with soil and vegetation. Conditions of rainfall and run-off are easily determined, but were not considered in construction of the bridge destroyed in this flood.

O'Hara, Thomas.

Flood on Bluefields river banana lands. 500 w. 1896. (In United States consular reports. Sept. 1896, v.52, no.192, p.207.)

Letter from British vice-consul at Bluefields, Nicaragua, to British consul at San Juan del Norte, sent by O'Hara.

Sluice box and flood gate construction; Fraser valley reclamation, British Columbia. 1,100 w. 1 ill. 1897. (In Engineering news, v.38, p.55.)

Replacing others destroyed by floods.

Traill, W. E.

Nature on the rampage. 1,000 w. 1907. (In Canadian magazine, v.29, p.294.)

Describes writer's impressions during ice flood at Hudson Bay Company's post on Peace river, Canada, 1888.

FOREIGN RIVERS. FLOODS AND METHODS OF FLOOD RELIEF.

British

Bateman, John Frederic.

Flood water of rivers. 900 w. 1863. (In Minutes of proceedings of the Institution of Civil Engineers, v.22, p.362.)

Data on several English rivers.

Bazalgette, Edward.

Victoria, Albert and Chelsea embankments of the river Thames. 11,500 w. 2 folding pl. 1878. (In Minutes of proceedings of the Institution of Civil Engineers, v.54, p.1.)

Discussion, 13,000 w.
History and description of Thames improvement works, not limited to those indicated in title. Holds that increased flood and tide heights and consequent overflows are not due to embankments. This view is supported by discussion.

Broome, Jeremy.

Floods. 1,800 w. 18 ill. 1897. (In Strand magazine, v.13, p.441.)

Popular description of a number of floods, mostly in England and West Indies.

England—Royal commission on canals and waterways.

Report (1st-4th), 1906-11. v.1-12.

1. Minutes of evidence and appendices thereto accompanying the first report. 470+111 p. 1906. Map of the canal systems and navigable rivers of England and Wales.
2. Ireland. 321+54 p. 1907. Map of the canal systems and navigable rivers of Ireland.
3. England and Wales and Scotland. 643+217 p. 1908. Map of the canal systems and navigable rivers of Scotland.
4. Returns, comprising the history, the extent, the capital of and the traffic and works on the canals and inland navigations of the United Kingdom. 510 p. 1908. Tables showing length, number of locks, number of tunnels, etc., in respect of each canal or navigation in England, Ireland, Scotland and Wales.
5. England and Wales and Scotland. 388+79 p. 1909.
6. Foreign inquiry; report on the waterways of France, Belgium, Germany and Holland. 223 p. Numerous maps and tables.
7. Final report, England and Wales and Scotland. 237+29 p. 1909.
8. Appendices to the fourth and final report, England and Wales and Scotland. 247 p. 1910.
9. Reports...on the cost of improving canal routes. 214 p. 1910. Includes statistical surveys of canal routes and many drawings showing longitudinal sections of canal routes.
10. Reports on the water supplies of canal routes. 241 p. 1911. Numerous diagrams, longitudinal sections and plans of routes showing existing canals, proposed alterations, sources of water-supply, reservoirs, streams and pumping stations and particulars of the catchment areas and rainfall stations.
11. Final report on the canals and inland navigations of Ireland. 91 p. 1911. Discusses history and present conditions, reasons for non-improvement by private enterprise, question of extensions and improvements, recommendations as to improvement and control.
12. Appendices to the final report on the canals and inland navigations of Ireland. 37 p. 1911.

Exhaustive study of the waterways of the United Kingdom, and of considerable interest even though not dealing directly with flood prevention.

Flood and its lessons. 2,500 w. (In Chamber's journal, v.32, n. s. v.12, p.81.)

Experiences and flood conditions in England. Urges river and stream improvement and more attention to general drainage.

Floods. 2,400 w. 1884. (In Nineteenth century, v.15, p.94.)

Deals with conditions in England and duties of conservancy boards. Considers it "desirable to restrict floods within such limits as are possible without immoderate or disproportionate outlay."

Floods on English rivers. 1,500 w. 1903. (In Spectator, v.91, p.383.)

"Present year (1903) has seen more floods than any recorded period of the same length." Deals with their causes and phenomena.

Forbes, Urquhart A.

Prevention of floods. 3,000 w. 1881. (In Macmillan's magazine, v.43, p.321.)

Considers English rivers. Mentions several schemes for organization and supervision of work, favoring that proposed by Mr. Magniac—to establish small boards for local work, larger boards representing the county, and a General Conservancy Board to have charge of the whole. Does not deal with methods.

Gloyne, R. M.

Construction of the most recent flood prevention works in Eastbourne. 2,500 w. 1897. (In Builder, v.72, p.532.)

Author is the borough engineer. Describes works being constructed under his supervision to prevent the flooding of parts of the city. Mainly the abandonment of old sewerage systems and construction of a modern high-level system of greater capacity.

Greaves, Charles.

On evaporation and on percolation. 13,000 w. 3 ill. 1876. (In Minutes of proceedings of the Institution of Civil Engineers, v.45, p.19.)

Appendix, 20 p. Tables of rainfall, percolation and evaporation.
Discussion, 30,000 w. p. 48. Considers also paper by Symons.
Includes causes of floods and storage of flood water, with reference to conditions in England.

Jacob, Arthur.

Conservancy of rivers; the valley of the Irwell. 16 p. 1 folding pl. 1881. (In Minutes of proceedings of the Institution of Civil Engineers, v.67, p.233.)

Discussion and correspondence, 82 p. 3 ill. p.249. Considers also paper by Wheeler.
Defines river conservancy in its broadest sense, but deals with only one phase—flood abatement.

Lauder, Sir Thomas Dick.

Account of the great floods of August, 1829, in the province of Moray and adjoining districts. 25 p. 1830. (In Westminster review, v.13, p.350.)

Review of book with above title, published by Adam Black, Edinburgh, 1830. 418 p.

Management of rivers, 1,100 w. 1880. (In Engineer, London, v.50, p.445.)

Editorial plea for more efficient regulation of English rivers. Partial reference to flood prevention.

Prevention of floods. 1,500 w. 1880. (In Engineer, London, v. 50, p.388.)

The same. (In Van Nostrand's engineering magazine, v.24, p.131.)

Editorial outline of plans for organization and administration of the work in England.

Symons, George James.

On the floods in England and Wales during 1875, and on water economy. 8,000 w, 1 ill. 6 rainfall maps. (In Minutes of proceedings of the Institution of Civil Engineers, v.45, p.1.)

Appendix, 4 p. Rainfall tables.
Discussion, 30,000 w. p.48. Considers also paper by Greaves.
"The number as well as the volume of the floods of 1875 having been extremely unusual, the author has been led to believe that a brief record of their causes and effects, together with some remarks on other great floods of the past and present centuries, might be acceptable."

Wheeler, William Henry.

Conservancy of rivers; the eastern Midland district of England. 32 p. 1 folding pl. 1881. (In Minutes of proceedings of the Institution of Civil Engineers, v.67, p.201.)

Discussion and correspondence, 82 p. 3 ill. p.249. Considers also paper by Jacob.
Rivers here dealt with are typical of the drainage systems of flat districts of permeable strata, discharging into sandy estuaries; with small rainfall and no mountain torrents. Points to the advantage of a comprehensive general scheme of flood control over local attempts.
Cause of Floods, p.217, 250.

French

See also Flood Prediction.

Belgrand, E.

Note sur le groupe de pluies du 21 au 24 juin 1875; crue de la Garonne; désastres de Toulouse. 4,500 w. 1876. (In Comptes rendus des séances de l'Académie des sciences, v.81, p.1017, 1082, 1168.)

The same, condensed translation. 300 w. (In Minutes of proceedings of the Institution of Civil Engineers, v.44, p.261.)

Floods of the Garonne and other rivers in France.

Belgrand, E.

Note sur les crues de la Seine et de ses affluents. 5,000 w. 1872. (In Comptes rendus des séances de l'Académie des sciences, v.75, p.1584, 1675.)

Extract from his book, "La Seine; études hydrologiques."

Belgrand, E.

La Seine; études hydrologiques. 1,500 w. 1873. (In Comptes rendus des séances de l'Académie des sciences, v.76, p.1172.)

Review of his book with above title, which deals in part with floods.

Belgrand, E.

Sur la crue de la Seine de février-mars 1876. 1,000 w. 1876. (In Comptes rendus des séances de l'Académie des sciences, v.82, p.596.)

The same, condensed translation. 200 w. (In Minutes of proceedings of the Institution of Civil Engineers, v.44, p.262.)

Causes and comparison with floods of other French rivers.

Belgrand, E.

Sur la crue de la Seine et sur les moyens de préserver Paris des débordements du fleuve. 2,000 w. 1876. (In Comptes rendus des séances de l'Académie des sciences, v.82, p.1086.)

The same, condensed translation. 500 w. (In Minutes of proceedings of the Institution of Civil Engineers, v.46, p.299.)

Points out advisability of raising quays and of cutting off, in flood time, all connection between river and present sewers, removing sewage either by pumping or by discharging further down the river.

Belgrand, E.

Sur la crue de la Seine, le 23 janvier 1873. 300 w. 1873. (In Comptes rendus des séances de l'Académie des sciences, v.76, p.189.)

Measurements and observations.

Belgrand, E.

Sur le débit de la Seine et sur la crue du 17 mars 1876. 300 w. 1876. (In Comptes rendus des séances de l'Académie des sciences, v.82, p.659.)

The same, translated. (In Minutes of proceedings of the Institution of Civil Engineers, v.45, p.308.)

Comparison with other Seine floods. Possibility of accurate flood prediction.

Belgrand, E. & **Lemoine, G.**

Étude de la grande crue de la Seine en mars 1876. 12,000 w. 1877. (In Annales des ponts et chaussées, mémoires, ser.5, v.13, p.435.)

The same, condensed translation. 400 w. (In Minutes of proceedings of the Institution of Civil Engineers, v.50, p.221.)

Greatest since 1807. Below Paris slight damage was done. This is attributed to absence of embankments and to the ample warnings given by the Hydrological department.

Dumas, A.

Crue de la Seine, de janvier, 1910. 9,000 w. 4 diag. 2 dr. 19 ill. 3 maps. 1910. (In Génie civil, v.56, p.257.)

Reviews history of the flood and gives measurements of recent and former floods.

Dumas, A.

Effets de la crue de la Seine du 28 janvier 1910 dans Paris et sa banlieue. 7,500 w. 5 diag. 4 dr. 10 ill. 2 maps. 1910. (In Génie civil, v56, p.397.)

Descriptive article dealing with temporary and permanent effects.

Dumas, A.

Rapport de la commission chargée de rechercher les causes des inondations et les moyens d'en empêcher le retour. 7,000 w. 2 diag. 1 map. 1910. (In Génie civil, v.56, p.283.)

Review of an extensive report, embodying 20 questions to be referred to experts, either members of the commission or sub-committees.

Engineering features of the recent floods in Paris. 4,500 w. 1 diag. 1 dr. 6 ill. 1 map. 1910. (In Engineering news, v.63, p.327.)

Causes, effects and descriptive data.
Editorial, 400 w., p.343.

Floods in the Seine. 3,500 w. 1 map. 1910. (In Engineering, v.89, p. 149.)

Comparison of recent and former floods. Conditions and causes of flood of Jan., 1910.

Great Paris flood. 500 w. 14 ill. 1910. (In Scientific American supplement, v.69, p.129.)

Descriptive article reprinted from "New York Sun."

Harcourt, Leveson Francis Vernon-.

River Seine. 48 p. 4 folding pl. 1886. (In Minutes of proceedings of the Institution of Civil Engineers, v.84, p.210.)

Discussion and correspondence, 102 p. 9 ill.
Includes rainfall, floods of the Seine and prediction of floods.

Jollois.

Mémoire sur les crues de la Loire supérieure. 25 p. 1880. (In Annales des ponts et chaussées, mémoires, ser.6, v.1, p.273.)

Tables, 22 p.
Describes upper Loire and its branches, rainfall and flood calculation. Divides floods of this region into four types, describing each.

M., P. W. S.

Floods in France. 4,500 w. 1876. (In Leisure hour, v.25, p.68.)

Value of flood prediction; causes and prevention of floods.

Miller, Warren H.

Fighting the Paris flood. 2,900 w. 4 ill. 1910. (In Engineering record, v.61, p.240.)

Description of the flood of Jan., 1910, the most destructive in the history of Paris and the highest since 1658. Briefly outlines precautionary measures during flood stage.

Moore, Barrington.

Checking floods in the French Alps. 2,300 w. 9 ill. 1910. (In American forestry, v.16, p.199.)

Describes and illustrates work of barrage construction in mountain streams, and of gradual reforestation of mountain slopes.

Paris flood. 600 w. 1910. (In Engineering news, v.63, p.133.)

Discussion of flood of Jan., 1910.

Paris floods and their prevention. 400 w. 1910. (In Scientific American supplement, v.69, p.217.)

Popular review of proposed work.

Proposed structures to prevent future damage from floods at Paris. 400 w. 1910. (In Engineering news, v.64, p.91.)

Abstract of report of the commission of engineers appointed following the flood of Jan., 1910. Proposes a thorough study of entire drainage area of the Seine; treatment of Seine channel and banks through Paris; raising of certain quay walls two feet above flood height of 1910; construction of sewer valves; thorough waterproofing of subways; and construction of by-pass canal to carry part of flood water around the city. Reforestation is discussed and considered advisable.

Roberts, Thomas P.

Floods in the river Seine; remarks on proposed means to mitigate flood conditions at Paris. 20 p. 1 map. 1910. (In Proceedings of the Engineers' Society of Western Pennsylvania, v.26, p.25.)

With discussion.
Considers soil conditions and other features of the Seine basin, giving some comparison with American streams. Offers suggestions for ameliorating flood conditions, but makes no definite recommendations. Mentions raising level of city, deepening and straightening of channel, etc.

Das Seine-Hochwasser in Paris von Januar 1910. 2,000 w. 2 diag. 1 map. 2 tables. 1910. (In Zeitschrift des österreichischen ingenieur-und architekten vereins, v.62, p.174.)

Description and comparison with other Seine floods.

Soper, George A.

Water supply, sewerage and subways of Paris in relation to the present floods. 6,000 w. 8 dr. 4 ill. 1910. (In Engineering news, v.63, p.144.)

Considers hydrology of the Seine, subterranean structures, population and city plan, dual water-supply, sewers, sewage farms, subways and danger of epidemic.
Editorial, 600 w., p.133.

German

See also Ice and its Effects

Beyerhaus, Eduard.

Der Rhein von Strassburg bis zur holländischen grenze in technischer und wirthschaftlicher beziehung. 128 p. 7 folding pl. 1902.

Describes the regulation work done on the Rhine and the various harbors established. Statistical information concerning freight handled, number of vessels employed, etc., is given, together with a discussion of the influence of the river on the industrial life of the district. Numerous maps and plans are included.

Intze, O.

Talsperrenanlagen in Rheinland und Westfalen, Schlesien und Böhmen. 48 p. 4 dr. 13 ill. [1904?]

Pamphlet describing exhibit of Königlich preussischen ministeriums der öffentlichen arbeiten, at St. Louis Exposition, 1904. Deals with work since 1889.

Jasmund, R.

Die arbeiten der Rheinstrombauverwaltung, 1851-1900; denkschrift anlässlich des 50 jährigen bestehens der Rheinstrombauverwaltung und bericht über die verwendung der seit 1880 zur regulierung des Rheinstroms bewilligten ausserordentlichen geldmittel; nach amtlichen materialien bearbeitet. 242 p. 234 ill. [1901.]

Detailed description of the Rhine regulation work as carried out in 1851–1900. Contains numerous maps, plans, photographs, etc., showing the condition of the river at various times and places, methods and machinery used. Costs of various portions of the work are given.

Keller, Hermann, ed.

Memel-, Pregel- und Weichselstrom; ihre stromgebiete und ihre wichtigsten nebenflüsse; eine

hydrographische, wasserwirthschaftliche und wasserrechtliche darstellung; im auftrage des preussischen wasser-ausschusses hrsg. 6v. 1899. Reimer.

v.1. Stromgebiete und gewässer.
v.2. Memel- und Pregelstrom.
v.3. Weichselstrom in Schlesien und Polen.
v.4. Weichselstrom in Preussen.
v.5. Tabellenband.
v.6. Kartenbeilagen.

Very complete study of physical and economic conditions in the drainage basins of these rivers. Statistical, meteorological and hydrographic data are tabulated and numerous large hydrographic, geological and economic charts are included.

Keller, Hermann, ed.

Weser und Ems; ihre stromgebiete und ihre wichtigsten nebenflüsse; eine hydrographische wasserwirthschaftliche und wasserrechtliche darstellung; im auftrage des preussischen wasser-ausschusses hrsg. 6v. 1901. Reimer.

v.1. Stromgebiete und gewässer.
v.2. Quell- und nebenflüsse der Weser (ohne Aller).
v.3. Die Weser von Münden bis Geestemünde.
v.4. Die Aller und die Ems.
v.5. Tabellenband.
v.6. Kartenbeilagen.

Thorough study of hydrographic conditions in their drainage basins and of their effect on the industrial development of the region. Statistical data of a hydrographic and meteorological nature are tabulated and good geological and hydrographic maps and charts are included.

Maillet, Edmund.

Etude hydrologique du Rhin allemand et du Main, les crues et leur prévision. 22 p. 1 map. 1903. (In Annales des ponts et chaussées, mémoires, ser.8, v.10, p.200.)

Abstract of a 430 p. folio report which investigates in detail the flood conditions in these two river valleys.

Roloff, P.

Statistische nachweisungen über ausgeführte wasserbauten des preussischen staates. 136 p. Ill. 1907.

"Umgearbeiteter und erweiterter abdruck aus der Zeitschrift für bauwesen, jahrgang 1900, 1901 und 1904."

Tabulated statistics showing the cost of much of the construction work carried out since 1890. Includes river regulation, harbors, dikes, retaining walls, locks, weirs, highways, bridges, aqueducts, siphon aqueducts, inverted siphons, safety gates, etc. Total cost and detailed cost of the main portions of each work are given, with brief descriptions and sketches showing their exact character.

Sympher, Arthur Leo.

Die neuen wasserwirtschaftlichen gesetze in Preussen; im auftrage des preussischen herrn ministers der öffentlichen arbeiten für den X. Internationalen Schiffahrt-Kongress in Mailand zusammengestellt. 108 p. 1905.

Gives the text of five Prussian laws passed in 1904 and 1905, relating to the improvement of internal waterways and the prevention of floods, with brief explanations of the conditions which have existed and which these laws are intended to modify.

Italian

Adams, Frank D.

Embankments of the river Po. 1,500 w. 1896. (In Science, v.26, n. s. v.3, p.759.)

Criticizes Lyell's statement that river-bed has risen till it is higher than plains on either side. Danger from Po floods is minimized by irrigating ditches and by system of secondary embankments.

Asta, D.

On the prevention of floods in rivers. 1,500 w. 1883. (In Minutes of proceedings of the Institution of Civil Engineers, v.76, p.395.)

Abstract from "Il Politecnico," 1883, p.470.

Discusses various methods. Considers it inadvisable to abandon the existing systems of embankments on Italian rivers and deems the maintenance and improvement of these embankments the best solution.

Barilari.

Survey of the course of the Po. 1,600 w. 1877. (In Minutes of proceedings of the Institution of Civil Engineers, v.49, p.330.)

Abstract from "Giornale del genio civile," v.14, p.611.

Work of commission appointed following the great floods of 1872.

Artificial banks were considered inapplicable and the object sought was reduction of flood volumes, or at least an arrest of their increase. Involves investigation of: forest conditions; construction of storage basins; diversion of tributaries; channel rectification and improvement of mouths of river.

Gallizia, P.

Floods of the river Po in the nineteenth century. 1,000 w. 1878. (In Minutes of proceedings of the Institution of Civil Engineers, v.54, p.300.)

Abstract from "Giornale del genio civile," v.16, p.3, 41, 125.

Original gives very full data on floods and flood measurements. Relief is anticipated through passage of forest law and through scour to be secured by the construction of discharge channels as far as possible into the Adriatic.

Pareto, R.

On the works proper to prevent the inundations of the Tiber in the city of Rome. 2,000 w. 1877. (In Minutes of proceedings of the Institution of Civil Engineers, v.49, p.334.)

Abstract from "Giornale del genio civile," v.-14, p.84, 97, 175, 209, 258.
Favorable and unfavorable features of the following plans: reforestation of river banks; storage reservoirs; total deviation of Tiber; partial deviation of Tiber; limitation of the flow of river admitted to city; rectification of channel; additions to banks.

Report of the Commission for preventing inundation from the Tiber in the city of Rome. 300 w. 1877. (In Minutes of proceedings of the Institution of Civil Engineers, v.49, p.333.)

Abstract from "Giornale del genio civile," v.14, p.379, 419.
Details of 19 submitted plans. Recommends channel regulation above and within the city.

Shelford, William.

On rivers flowing into tideless seas, illustrated by the river Tiber. 9,000 w. 4 diag. 1885. (In Minutes of proceedings of the Institution of Civil Engineers, v.82, p.2.)

Discussion and correspondence, 50 p. 4 ill.
Has a section on protection of Rome from inundation.

Vescovali, Angelo.

Hydrometric observations on the river Tiber. 1,200 w. 1875. (In Minutes of proceedings of the Institution of Civil Engineers, v.43, p.356.)

Abstract from "Giornale del genio civile," June, July, August, 1875, 80 p. 6 pl.
Comparison of various floods. Shows how deepening and straightening of channel will lead to great reduction of flood-level.

Miscellaneous

Boyle, Richard Vicars.

On the flood of September 16th, 1878, in the Rokugo river. 300 w. 1881. (In Minutes of proceedings of the Institution of Civil Engineers, v.68, p.228.)

Appendix to paper on Rokugo river bridge (Tokio-Yokohama railway) which withstood this flood.

Davis, W. M.

Gohna landslip. 300 w. 1897. (In Science, v.28, n. s. v.5, p.437.)

In 1893 an immense landslide in the Himalayas dammed a narrow valley and caused formation of a lake. During rainy season of following year this natural dam failed. In anticipation of the flood, bridges were dismantled and telegraphic service established with lower valley. Loss was therefore very light.

De la Brosse, R.

Note sur le régime de la Theiss et les digues de Szegedin. 37 p. 10 ill. 1890. (In Annales des ponts et chaussées, mémoires, ser.6, v.20, p.512.)

Describes plains of Hungary and construction of protective works for the town of Szegedin.

Gohna landslip and flood. 4,000 w. 1896. (In Engineer, London, v.81, p.413.)

Gonda, B.

On the means for protecting the county of Torontál (Hungary) from the inundations by the rivers Theiss and Maros. 300 w. 1876. (In Minutes of proceedings of the Institution of Civil Engineers, v.46, p.296.)

Abstract from "Journal of the Hungarian Society of Engineers and Architects," v.6, p.276.
Embankments have several times been partly or wholly destroyed. Besides strengthening these, the Theiss is to be connected to several canal systems and some channel improvements made.

Gordon, Robert.

Hydraulic work in the Irawadi delta. 31 p. 3 diag. 1893. (In Minutes of proceedings of the Institution of Civil Engineers, v.113, p.276.)

Appendixes, 6 p. Tables of discharge, flood heights, etc.
Extensive embankments and their effect on floods.

Howden, Andrew Cassels.

Floods in the Nerbudda valley, with remarks on monsoon floods in India generally. 5,000 w. 1 folding pl. 1868. (In Minutes of proceedings of the Institution of Civil Engineers, v.27, p.218.)

Discussion, 23,000 w. p.229. Considers also paper by O'Connell. (See reference under General.)
Effect of various natural "flood-regulators"—lakes, swamps, glaciers, p.230, 243; cracks and fissures in dry earth, p.247; forests, p.255.

Kohut, Moriz.

Die Oppa-regulierung in Jägerndorf. 1,600 w. 1 dr. 1 map. 1901. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.53, pt.2, p. 640.)

Dike protection for a Bohemian town.

Lauda, Ernst.

Das generelle regierungsprojekt für die ergänzung der hochwassershutzmassnahmen in der Wiener Donaustromstrecke. 7,500 w. 17 diag. 1 dr. 2 tables. 1910. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v 62, p.437.)

Lauda, Ernst.

Schutz von Wien gegen die hochwasser der Donau. 7,500 w. 5 diag. 5 ill. 11 tables. 1910. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.62, p.457.)

Lauda, Ernst.

Schutz von Wien gegen die hochwassergefahren der Donau. 2,000 w. 5 diag. 1 table. 1910. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.62, p.772.)

List, G. H.

Flood damages, N. W. R., India. 1,800 w. 5 ill. 1906. (In Engineer, London, v.101, p.336.)

Flood in July, 1892, caused by a rainfall of 11 inches in six days. Bridges, track and retaining walls on the North-Western railway were washed out.

Morrison, G. James.

On the breach in the embankment of the Yellow river. 5,700 w. 3 ill. 2 maps. 1893. (In Engineering, v.55, p.263, 295.)

Flood of 1887. Methods of repairing a large break.

Nile floods and monsoon rains. 1,300 w. 1900. (In Nature, v.62, p.391.)

Attempts to trace a connection between the extent of the Nile floods and the abundance or deficiency of the monsoon rainfall in India. Makes a plea for further scientific research in the hope of finding some means of dealing with this problem.

Prout, H. G.

Modern miracle. 800 w. 3 diag. 1897. (In McClure's magazine, v.10, p.45.)

Describes landslide and flood at Gohna, India, on a branch of the Ganges, 1893–94.

Ritter von Wex, Gustav.

Ueber die Donau-regulierung bei Wien. 9,000 w. 1876. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.28, p.77.)

The same, condensed translation. (In Minutes of proceedings of the Institution of Civil Engineers, v.46, p.294.)

Effect of floods caused principally by ice jams.

Singer, Max.

Über Flussregime und Thalsperrenbau in den Ostalpen. 16,500 w. 2 diag. 6 dr. 6 ill. 1909. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.61, p.797, 813.)

Some mountain torrents of Switzerland. 2,800 w. 25 diag. and ill. 1900. (In Engineer, London, v.88, p.106, 118, 159, 168, 188, 189, 192.)

Problems of regulation and control. These streams are dangerous by reason of the suddenness of their floods.

Starling, William.

Regulation of the Yellow river. 4,000 w. 2 dr. 17 ill. 1900. (In Engineering magazine, v.20, p.373.)

Concludes that regulation is entirely feasible, though the work thus far has not been intelligently done. "Sometimes the dikes are superfluously high and strong, sometimes they are altogether insufficient. They are always neglected. The river is suffered to get dangerously close to them, by bank erosion. The slopes are not protected by grass...and they are cut up by travel."

Waldvogel, Anton.

Wien von den hochfluten der Donau dauernd bedroht. 9,000 w. 12 diag. 4 dr. 6 ill. 6 maps. 1910. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v. 62, p.497, 765.)

Discussion, 20,000 w. 7 dr. 1 map.
Outlines history of Danube floods, shows Vienna's danger and discusses protective measures.

Walzel, A.

Ueber die in vorjahre von der Oesterr. Nordwestbahn getroffenen massnahmen gegen eine ueberfluthung des bahndammes zwischen Bisamberg und Stockerau. 4,500 w. 4 ill. 1 map. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v.52, p.173.)

Describes effective precautions taken.

Williams, Cyrus John Richard.

Floods in the Brisbane river [Australia], and a system of predicting their heights and times. 2,800 w. 2 diag. 1 map. 1899. (In Minutes of proceedings of the Institution of Civil Engineers, v.136, p.268.)

The same, condensed. 1,800 w. (In Engineering record, v.40, p.365.)

Appendix, 4 p.
In wet weather the observers send telegraphic reports daily, and with increased frequency until hourly reports are sent during dangerously high water. From these readings hydrographs are plotted and heights predicted for any point in advance of the maximum stage. Appendix compares observed heights of various floods with results computed by author's system.

GENERAL

Belpaire, Théodore.

On the advance of floods and on the influence of works of river improvement. 1,200 w. 1881. (In Minutes of proceedings of the Institution of Civil Engineers, v.66, p.405.)

Considers effect of rectification on hypothetical river of small size. Concludes that works of improvement accelerate propagation of the floods as long as discharge is less than that which causes overflow of improved channel.

Davis, Arthur P.

National irrigation and flood control. 1,600 w. 1908. (In Engineering record, v.58, p.554.)

By chief engineer United States reclamation service. Gives brief data on 27 projects in course of construction, 20 of which provide flood storage.

Flamant, and others.

Préservation des basses régions contre l'envahissement des eaux. 30 p. 1909. (In Annales des ponts et chaussées, mémoires, septembre-octobre, 1909, ser.8, v.41, p.91.)

Report at Eleventh International Congress of Navigation, St. Petersburg, 1908. Discusses at some length the reports of Kvassay for Austria-Hungary, Ockerson for the United States, Troté for France, Rytel for Russia and a general report by Golovnine.

Floods. 450 w. 1906. (In Nelson's encyclopædia, v.5, p.76.)

Floods through the failure of natural barriers. 1,500 w. 1889. (In Engineering news, v.22,p.81.)

Calls attention to dangers of this sort and gives two instances of Vermont lakes which broke through their banks and caused sudden floods of considerable proportions.

Francis, James B.

On the effect of a rapidly increasing supply of water to a stream on the flow below the point of supply. 3,000 w. 1889. (In Transactions of the American Society of Civil Engineers, v.21, p.558.)

Godbey, A. H.

Great disasters and horrors in the world's history. 612 p. Ill. 1890.

Includes Johnstown flood, floods in southern United States, in Holland, China and Japan. Description only.

Holliday, Alex R.

Control of flood water at a small reservoir. 600 w. 2 dr. 1908. (In Engineering news, v.60, p.152.)

Methods applicable to diversion of storm water on small scale.

Hutton, William R.

On the determination of the flood discharge of rivers and of the backwater caused by contractions. 30 p. 5 pl. 1881. (In Transactions of the American Society of Civil Engineers, v.11, p.211.)

Discussion.
As proof of the variation in expert evidence on this subject author goes at length into the "Elmira crossing case," where the N. Y. L. & W. R. R. sought to cross the N. Y. L. E. & W. at Chemung, necessitating high embankments across the Chemung valley.

La Brosse, R. de.

Dispositions à donner aux barrages des rivieres à grandes variations de débit et eventuellement à fort charriage de glaces, de manière à menager les intérêts de la navigation et de l'industrie. 36 p. 1909. (In Annales des ponts et chaussées, mémoires, mai-juin, 1909, ser.8, v.39, p.129.)

Report at Eleventh International Congress of Navigation at St. Petersburg, 1908. Discusses seven reports on the above subject, including one for the United States by Maj. W. L. Sibert.

Liability of city confining flood waters within banks of stream. 150 w. 1910. (In Engineering news, v.64, p.485.)

Note from "Case and comment," Oct., 1910. Recent Iowa decision (Walters v. Marshalltown, 120 N. W. 1046) holding that a municipality having raised a street grade so as to confine flood water of a stream to the channel, is not liable for damage thereby inflicted upon lower riparian property.

Lyell, Sir Charles.

Floods. 3,200 w. 1892. (In his Principles of geology, ed.11, rev., v.1, p.344.)

Brief description of floods in Scotland, Italy and United States.

Newell, F. H.

Hydrography of the arid regions. 159 p. 106 diag. 4 ill. 3 maps. 1892. (In United States—Geological survey. Annual report, v.12, pt.2, p.213.)

Arid regions of the United States. Includes (p.227) relative amount of flood waters; time of floods; intensity of floods; rainfall and river flow.

O'Connell, Peter Pierce Lyons.

On the relation of the fresh-water floods of rivers to the areas and physical features of their basins, and on a method of classifying rivers and streams with reference to the magnitude of their floods. 5,000 w. 2 folding pl. 1868. (In Minutes of proceedings of the Institution of Civil Engineers, v.27, p.204.)

Appendix 3p. Table of physical features of certain rivers.
Discussion, 23,000 w. p.229. Considers also paper by Howden. (See Howden, under Foreign river floods, Miscellaneous.)

Pollak, Ignaz.

Ueber flussregulierungen. 6,800 w. 6 diag. 1900. (In Zeitschrift des Österreichischen Ingenieur-und Architekten-Vereines, v. 52, p.477.)

Channel rectification alone is inadequate for prevention of floods.

Preliminary report of the Inland Waterways Commission. 4,800 w. 1908. (In Engineering news, v.59, p.247.)

Condensed form of president's message and report of commission.

Prevention of floods. 1,500 w. 1880. (In Engineer, London, v.50, p.351.)

Editorial. Presents urgency of river improvement for the mitigation of floods.

River Engineering. 13,000 w. 22 dr. 1886. (In Encyclopædia Britannica, v.20, p.571.)

Includes floods, their classification, causes, extent of prevention and the various methods.

Salisbury, Rollin D.

Work of running water. 60 p. Ill. 1907. (In his Physiography, p.114.)

A few illustrations of floods.

Vauthier, L. L.

De l'influence des travaux de régularisation sur le régime des rivières, notamment en ce qui touche les inondations. 53 p. 1901. (In Annales des ponts et chaussées, mémoires, ser.8, v.1, 2 trimestre, p.108.)

Paper at Eighth International Congress of Navigation.

APPENDIX No. 8.

RECEIPTS AND EXPENDITURES.

As stated elsewhere in this report, one of the first problems that confronted the Commission was the raising of sufficient funds to defray the expense of the investigations. The Chamber of Commerce, the parent of the Commission, contributed $1,000 as a preliminary fund. Various methods of raising the required fund were suggested and discussed, and at a meeting of the Finance Committee, held May 3, 1909, it was decided to make a request of property owners in the flood district to contribute on the basis of one mill on each dollar of the assessed valuation of their property, including buildings. These valuations were procured from the City Assessor's office, and the Commission at once proceeded to solicit contributions on the above basis. The amount contributed on this basis is shown in the financial statement as receipts "From Property Owners in Flood District," and the names of the contributors will be found in Appendix No. 9 under "Property Contributors."

After the Commission had made some progress it was apparent that many individuals and business concerns not owning property in the flood district, but indirectly affected by floods, were willing to aid the cause. From this source the receipts under the heading "General Contributions" were received. The names of those contributing in this way will be found in Appendix No. 9, under "General Contributors."

It was later decided, in order that the Commission might have a large and representative organization of men particularly interested in the work, to increase the membership and to request those who became members to contribute $250 each. The receipts from those who contributed and became members are shown in the financial statement as "Membership Contributions," and the names of such contributors are given in Appendix No. 9 under "Membership Contributors."

The City of Pittsburgh and the County of Allegheny have also contributed very generously to the Commission, as shown in the financial statement, and as noted at the beginning of this report under "History and Objects of the Commission."

The following is a brief summary of the receipts and expenditures of the Commission from November 2, 1908, to February 1, 1912.

RECEIPTS.

Chamber of Commerce	$ 1,000.00	
From property owners in flood district	55,380.07	
General contributions	1,600.00	
Membership contributions	6,990.00	
City of Pittsburgh	51,455.53	
County of Allegheny	7,500.00	
Interest earned	191.01	
Total receipts		$124,116.61
Balance on hand		13,532.84
Total expenditures		$110,583.77

EXPENDITURES.

ENGINEERING.

Office Expense			
Clerical services		$ 1,831.78	
Rent, maintenance, supplies and furniture		1,820.95	
Stationery and printing		350.82	
Postage		200.58	
Investigations			
Engineering supplies (field and office)		765.82	
Field equipment		879.48	
Drafting equipment		221.55	
†Municipality investigations:			
City Surveys, including drafting, etc		8,241.00	
Forestry investigations:			
Examination of forest conditions on Allegheny and Monongahela Basins by the U. S. Department of Agriculture		1,500.00	
Stream investigations:			
Appropriated to Water Supply Commission of Pennsylvania for establishing and maintaining stream gaging stations	$ 630.93		
Gaging stations maintained by Flood Commissision	606.00		
Hydrography (field and office)	2,625.91		
		3,862.84	
†Reservoir investigations:			
Field surveys, drafting, estimates, etc. (salaries, subsistence, and traveling expenses)		38,385.04	
†General engineering:			
Salary and traveling expenses of Engineer in Charge and salary of Principal Assistant Engineer		9,214.64	
†Work on Engineers' Report, salaries (since March 1, 1911)		10,096.29	
*Publication of report			
			77,370.79

ORGANIZATION.

Office Expense			
Clerical services		1,831.78	
Rent, maintenance, supplies and furniture		2,056.75	
Stationery and printing		350.82	
Postage		200.58	
Financing and Organization			
Salaries of Executive Director and Executive Secretary and expenses of Executive Director while financing the work; also expenses for luncheons, stereopticon lectures, printing, special stenographic and clerical work, and all other expenses incident thereto		22,281.42	
Constructive Campaign			
Salaries and expenses of Executive Director and Executive Secretary; also expense incurred in sending committees to Washington, D. C., Harrisburg, Pa., Charleston, W. Va., Annapolis, Md., and other points, in the interest of legislation		6,491.63	
			33,212.98
Total			$110,583.77

Notes: Actual survey work began July, 1909, and ended September, 1910.

The items under the headings "Office Expense" have been divided about equally between "Engineering" and "Organization."

†The salary of the Engineer in Charge has been apportioned among these items.

*The County of Allegheny has agreed to appropriate $10,000 in 1912 to cover the cost of printing and publishing this report.

APPENDIX No. 9.

CONTRIBUTORS TO FLOOD COMMISSION FUND.

December 2, 1908, to February 1, 1912.

PROPERTY CONTRIBUTORS.

Adams Co., S. Jarvis
Adderton, J. W.
Alexander Heirs, George
American Bridge Co.
American Foundry Co.
American Locomotive Co.
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Arbuckles & Company
Arbuthnot Estate, Charles
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Arbuthnot, W. S.
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Bank of Pittsburgh.
Barrett Manufacturing Co.
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Blackburn, W. W.
Boggs & Buhl
Braun Bros. & Co.
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Buhl, Henry, Jr.
Butler, Ralph
Byers Co., A. M.
Byers, J. F.
Carbon Steel Co.
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Carlin, W. J.
Carnegie Steel Co.
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Commonwealth Real Estate Co.
Commonwealth Trust Co.
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Crucible Steel Co. of America.
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Damascus Bronze Co.
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Davis, Harry
Denny, Matilda W.
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Elkins, George P.
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Fitzsimmons, J. A. & D.
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Fox, L. A.
Frauenheim, A. A.
Frick, H. C.
Furey, W. H.
Garrison Foundry Co., A.
Given, Irene H.
Given, J. L.
Gloeckler, Bernard
Gregg, Bessie Denny
Gwinner, Edward
Hacke Estate, Paul H.
Hanna, Jennie A.
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Hatheway, L. A.
Heinz, H. D.
Heinz Co., H. J.
Heppenstall Forge & Knife Co.

PROPERTY CONTRIBUTORS.—(Continued.)

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Kerr, Robert M. & Edward Snodgrass
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Knight, F. H.
Koehrer, John
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Lawrence, W. W.
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Long, Elizabeth
Lutz & Schramm Co.
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Maffett, Eliza
Malsch, Ferdinand
Marvin, S. S.
Mellon, J. R. & A. W. & R. B.
Mellor, Charles C., Estate
Mellor Company, C. C.
Methodist Book Concern
M. E. Church Union
Moorehead, A. S.
McCafferty, E. D.
McCague, George E.
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McCullough-Dalzell Crucible Co.
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National Casket Co.
National Tube Co.
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Nicola & Shenk
Obernauer Co., H.
Oil Well Supply Co.
Oliver Iron & Steel Co.
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Pennsylvania Salt Manufacturing Co.
Peoples National Bank
Phipps, Henry
Pittsburgh Block & Mfg. Co.
Pittsburgh Brewing Co.
Pittsburgh Club, The
Pittsburgh Clay Pot Co.
Pittsburgh Cold Rolled Steel Co.
Pittsburgh Dry Goods Co.
Pittsburgh Forge & Iron Co.
Pittsburgh Gage & Supply Co.
Pittsburgh Hyde & Tallow Co.
Pittsburgh & Lake Erie R. R. Co.
Pittsburgh Life & Trust Co.
Pittsburgh Piping & Equipment Co.
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Pore, William
Porter, J. C.
Prager, Edith
Pusey, G. W.
Richards & Company
Riggs, G. A.
Riter-Conley Manufacturing Co.
Roberts, Sadie
Rodd, M. W.
Rodgers Sand Co.
Rodgers, William B.
Safe Deposit & Trust Co.
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Saulman, Laura
Sawyer & Sister, S. E.
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Schauer, J.
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Schenley Estate, Mary E.
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Seaman-Sleeth Co.
Seibert, C. A.
Severance, F. W., Trustee
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Simpson, George L.
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Standard Ice Co.

PROPERTY CONTRIBUTORS.—(Continued.)

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Stanton, William
Stevenson, W. H.
Stifel Co., Charles F.
Stove & Range Co. of Pittsburgh
Strange, A.
Swift & Company
Thaw Estate
Titzel, Louis B.
Trask, M. H.
Union American Cigar Co.
Union National Bank
U. S. Plate Glass Co.
Vilsack, A. A. & A. J.
Vilsack Estate, Leopold
Walsh, J. L.
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Way, William A. & John W.
Werner, Oswald
West & Co., C.
Western Electric Co.
Westinghouse Air Brake Co.
Weyman, B. F.
Whitcomb, E. P.
Whitney, F. D.
Willock, S. M.
Young, Samuel
Zug Iron & Steel Co.

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Brackenridge, H. M.
Carnegie, Andrew
Crutchfield & Woolfolk
Hall, William M.
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Logan, Col. Albert J.
National Biscuit Co.
Pittsburgh Plate Glass Co.
Pittsburgh Provision & Packing Co.
Porter Company, H. K.
Rauh, Marcus
Western Pennsylvania Paper Co.
Winter, Emil

MEMBERSHIP CONTRIBUTORS.

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Alling & Cory Co.
Craig, Samuel G.
Equitable Meter Co.
Firth Sterling Steel Co.
Haines & Sons Co., J. B.
Heinz, Frederick
Heinz, Howard
Lockhart Iron & Steel Co.
May Drug Co.
Meyer Jonasson & Co.
Mueller, Sebastian
McClintic-Marshall Construction Co.
McConway & Torley Co.
McCreery & Company
Otis Elevator Co.
Pickering, M. H. Co.
Pittsburgh Plate Glass Co.
Pittsburgh Steel Co.
Rauh Bros. & Co.
Robinson, William H.
Rosenbaum Company
Spang, Chalfant & Co., Inc.
Standard Underground Cable Co.
United Engineering & Foundry Co.
Waverly Oil Works Co.
Woodwell & Co., Joseph

ACKNOWLEDGMENTS.

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The Engineer in Charge makes mention of valuable services rendered as follows: Principal Assistant Engineer Kenneth C. Grant in office studies for and preparation of some of the important parts of the report, and in contributing data relative to foreign methods of river regulation, collected during a trip abroad; Assistant Engineer F. E. Field, in connection with studies of flood control by reservoirs and various estimates of cost; Assistant Engineers E. L. Schmidt and F. W. Lyon, for efficient work both in field and office, the former assisting with many of the important details; Assistant Engineer W. P. Slifer, for assistance in the design of the peak reduction diagrams and in certain river computations; Hydrographer H. P. Drake, stream-flow measurements and computations; John Bradbury, draftsman; and other assistants in both field and office, particularly upon the former work, which was continued during a winter of almost unprecedented severity.

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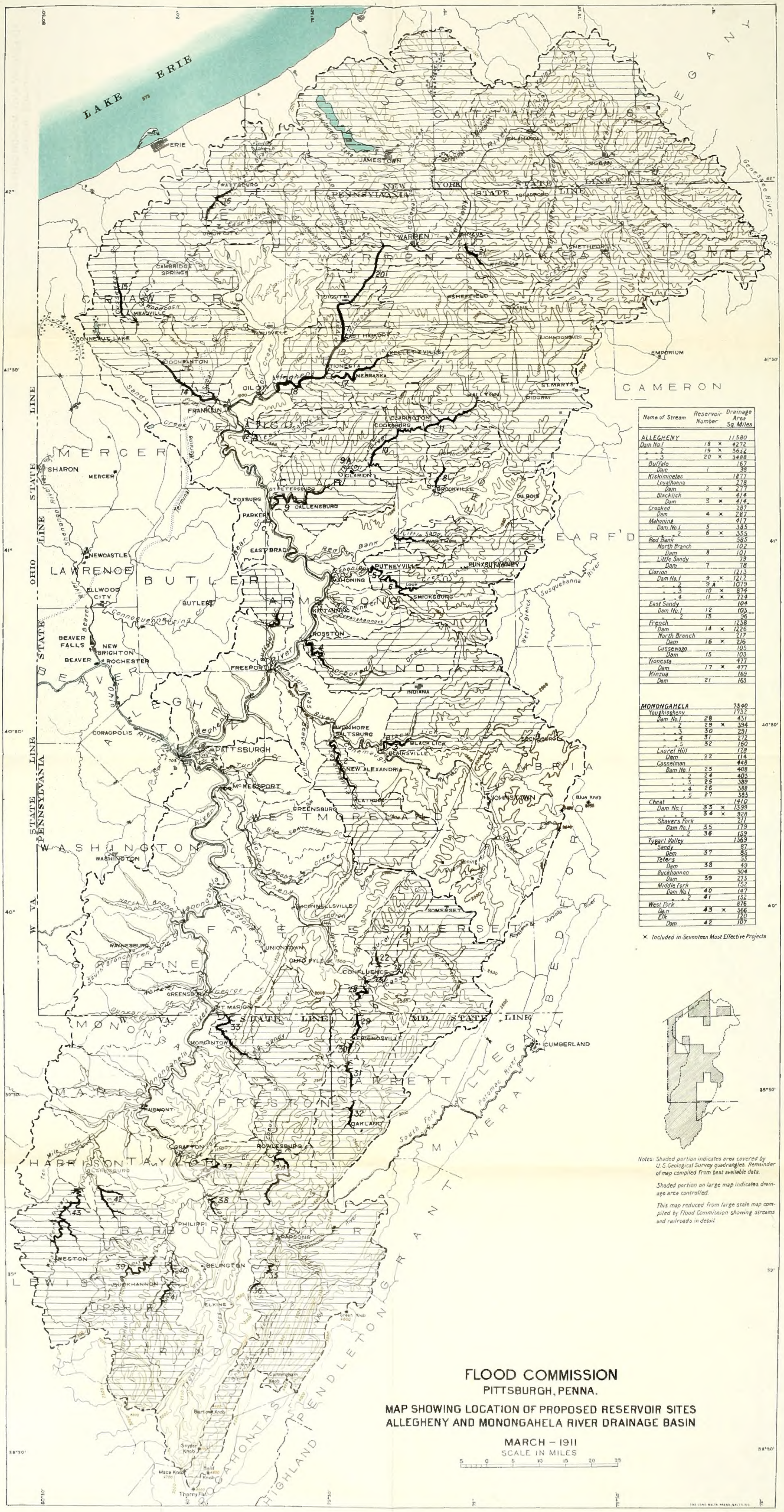
PRESS OF
MURDOCH-KERR CO.
PITTSBURGH, PA.



Name of Stream	Reservoir Number		Drainage Area Sq. Miles
ALLEGHENY			11580
Dam No. 1	18	×	4272
" " 2	19	×	3652
" " 3	20	×	3488
Buffalo			167
Dam	1		98
Kiskiminetas			1877
Loyalhanna			278
Dam	2	×	277
Blacklick			414
Dam	3	×	414
Crooked			287
Dam	4	×	287
Mahoning			417
Dam No. 1	5		385
" " 2	6	×	335
Red Bank			585
North Branch			102
Dam	8		101
Little Sandy			79
Dam	7		78
Clarion			1213
Dam No. 1	9	×	1212
" " 2	9 A		1079
" " 3	10	×	874
" " 4	11	×	724
East Sandy			104
Dam No. 1	12		103
" " 2	13		96
French			1238
Dam	14	×	1226
North Branch			217
Dam	16	×	216
Cussewago			105
Dam	15		103
Tionesta			477
Dam	17	×	477
Kinzua			169
Dam	21		163
MONONGAHELA			7340
Youghiogheny			1732
Dam No. 1	28		431
" " 2	29	×	394
" " 3	30		291
" " 4	31		272
" " 5	32		160
Laurel Hill			128
Dam	22		114
Casselman			448
Dam No. 1	23		408
" " 2	24		403
" " 3	25		389
" " 4	26		388
" " 5	27		383
Cheat			1410
Dam No. 1	33	×	1399
" " 2	34	×	928
Shavers Fork			211
Dam No. 1	35		179
" " 2	36		159
Tygart Valley			1369
Sandy			87
Dam	37		85
Teters			53
Dam	38		49
Buckhannon			304
Dam	39		273
Middle Fork			152
Dam No. 1	40		147
" " 2	41		132
West Fork			876
Dam	43	×	366
Elk			120
Dam	42		107

× Included in Seventeen Most Effective Projects

Notes: Shaded portion indicates area covered by U. S. Geological Survey quadrangles. Remainder of map compiled from best available data.

Shaded portion on large map indicates drainage area controlled.

This map reduced from large scale map compiled by Flood Commission showing streams and railroads in detail.

FLOOD COMMISSION

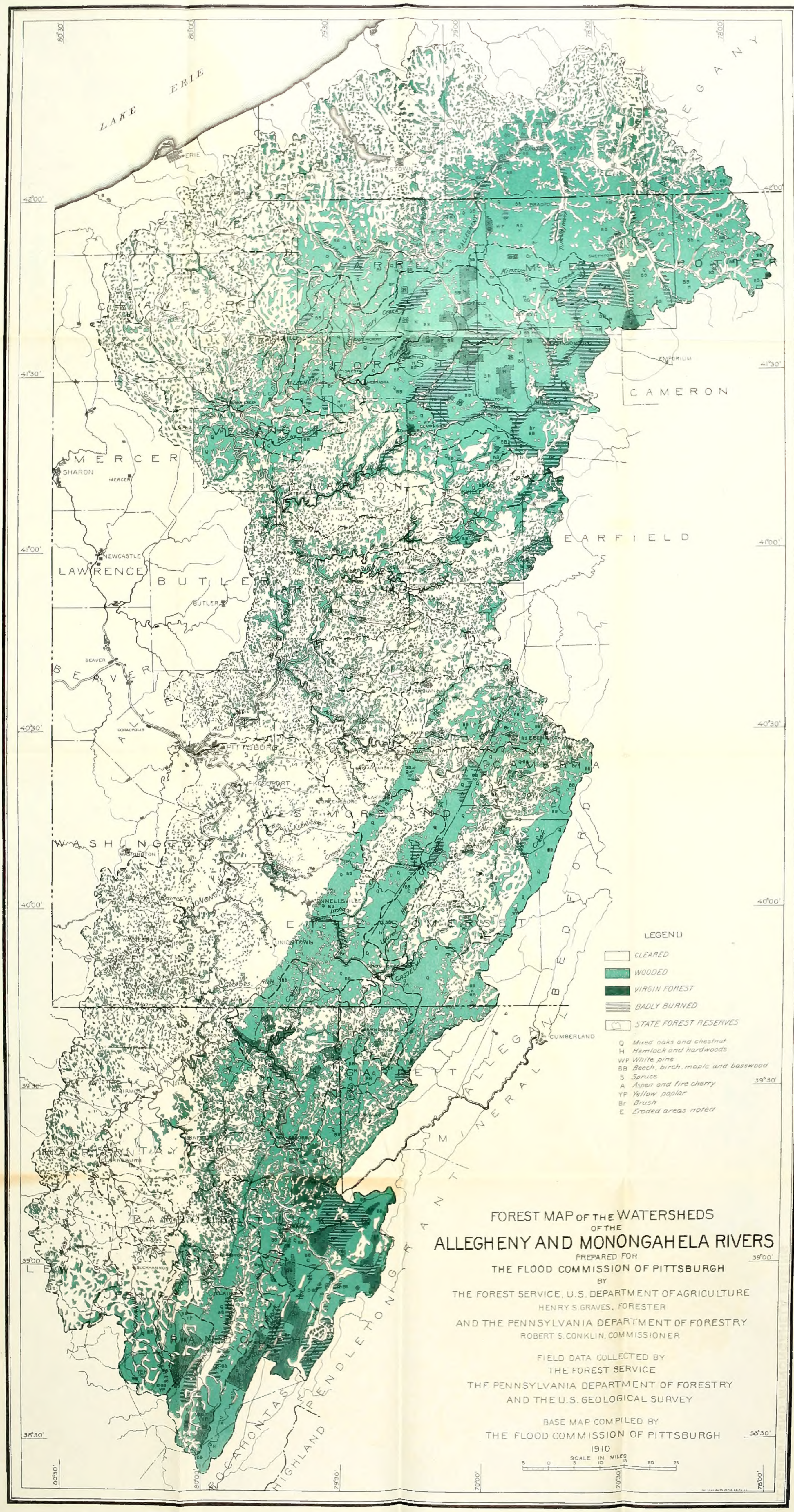
PITTSBURGH, PENNA.

MAP SHOWING LOCATION OF PROPOSED RESERVOIR SITES ALLEGHENY AND MONONGAHELA RIVER DRAINAGE BASIN

MARCH – 1911

SCALE IN MILES

5 0 5 10 15 20 25



LAKE ERIE
ERIE
CRAWFORD
WARREN
MCKEAN
POTTER
ALLEGANY
FOREST
ELK
CAMERON
EMPORIUM
VENANGO
MERCER
SHARON
MERCER
CLARION
CLEARFIELD
LAWRENCE
NEWCASTLE
BUTLER
BUTLER
BEAVER
BEAVER
CORAOPOLIS
PITTSBURG
MCKEESPORT
WESTMORELAND
CAMBRIA
WASHINGTON
WASHINGTON
FAYETTE
SOMERSET
UNIONTOWN
CONNELLSVILLE
GREENE
BEDFORD
CUMBERLAND
MINERAL
GARRETT
PENDLETON
POCAHONTAS
HIGHLAND
LEGEND
CLEARED
WOODED
VIRGIN FOREST
BADLY BURNED
STATE FOREST RESERVES
Q Mixed oaks and chestnut
H Hemlock and hardwoods
WP White pine
BB Beech, birch, maple and basswood
S Spruce
A Aspen and fire cherry
YP Yellow poplar
Br Brush
E Eroded areas noted
FOREST MAP OF THE WATERSHEDS OF THE
ALLEGHENY AND MONONGAHELA RIVERS
PREPARED FOR
THE FLOOD COMMISSION OF PITTSBURGH
BY
THE FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
HENRY S. GRAVES, FORESTER
AND THE PENNSYLVANIA DEPARTMENT OF FORESTRY
ROBERT S. CONKLIN, COMMISSIONER
FIELD DATA COLLECTED BY
THE FOREST SERVICE
THE PENNSYLVANIA DEPARTMENT OF FORESTRY
AND THE U.S. GEOLOGICAL SURVEY
BASE MAP COMPILED BY
THE FLOOD COMMISSION OF PITTSBURGH
1910
SCALE IN MILES
5 0 5 10 15 20 25
42°00'
41°30'
41°00'
40°30'
40°00'
39°30'
39°00'
38°30'
80°30'
80°00'
79°30'
79°00'
78°30'
78°00'